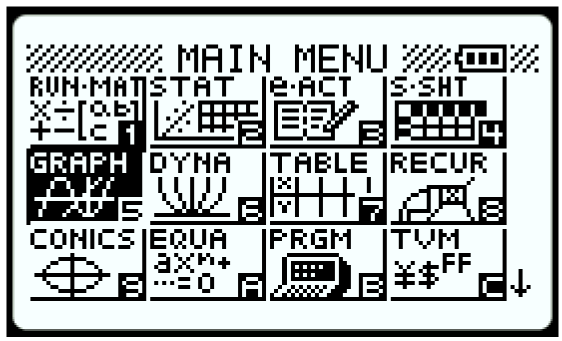
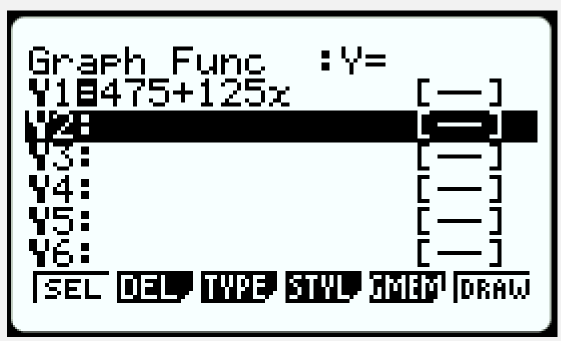
CASIO

Unit 2: Linear Equations, Inequalities and Systems	
Four-Function Calculator Recommended	Lessons 6, 8, 9
Graphing Technology Required	Lessons 5, 12, 14, 15, 16, 17, 23, 24, 26
Graphing Technology Recommended	Lessons 11, 13, 19

Lesson 5 – Graphing an Equation, Adjusting the Window, and Finding X and Y-Values

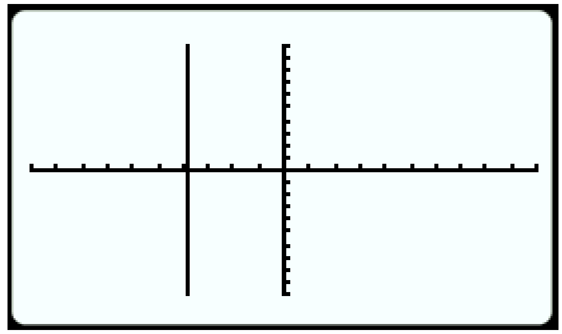
(Example: IM Lesson 5.3: Graph it! Question 1: Savings Account)

1. This task asks to graph an equation to model the amount of money a student has in a savings account as a function of time. Press [MENU], [5] - [GRAPH] to open the Graph app.	
2. The student starts with $475 in the account and deposits $125 weekly. This can be modeled with the equation **A = 475 + 125w**. The calculator always uses "***y***" for the dependent/output variable and "***x***" for the independent/input variable. To enter "***x***" press [X,θ,T]. Once you have entered the entire equation, press [EXE].	

3. Next, press **F6** – **DRAW** to graph the line.

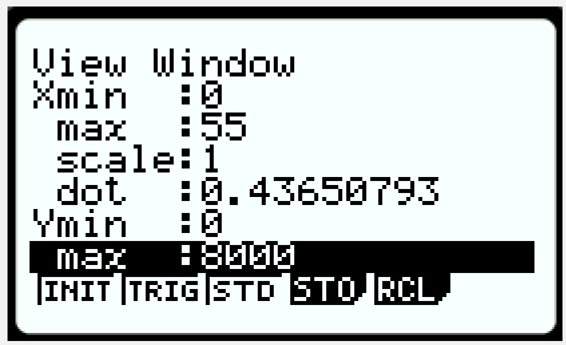
4. The window will need to be adjusted from the standard view for this graph. To adjust the window, press **F3** - **V-Window**.

   NOTE: Some like to adjust the viewing window **before** graphing initially. This can be done in the graph entry page by pressing **SHIFT** **F3** - **V-Window** there.

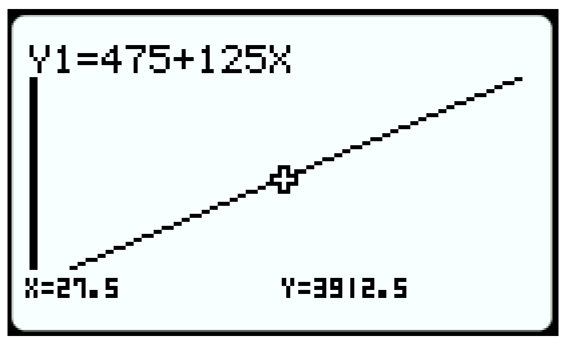


5. Since weeks can only go forward from the start, set **Xmin**: 0. Press **EXE** and the calculator will then be ready for entering the **Xmax**. We can estimate to start with 55 for a bit over a years' time to be shown. Press **EXE** (Often, we may have to return to readjust our window.)

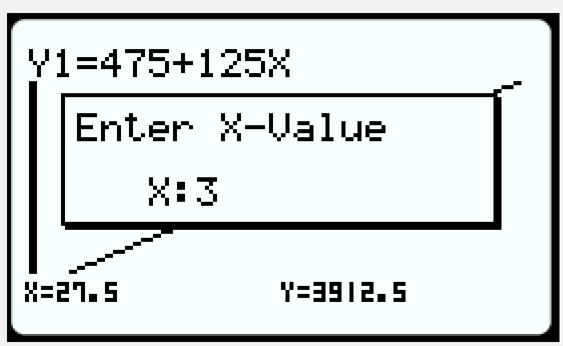
6. Next, press ▼ to move to **Ymin**. Set **Ymin** to 0, press **EXE** and enter 8000; since the student has a goal of $7000 for college. Press **EXE**



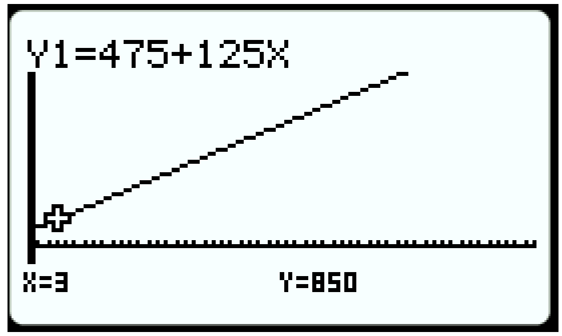
7. Next, we are asked to determine the amount in the account after 3 weeks. This would be the ***y*** value when ***x*** is 3. To do this, utilize the **TRACE** command. Press **F1** -**TRCE**. The equation of the graph and the coordinates of a point on the graph are then shown.

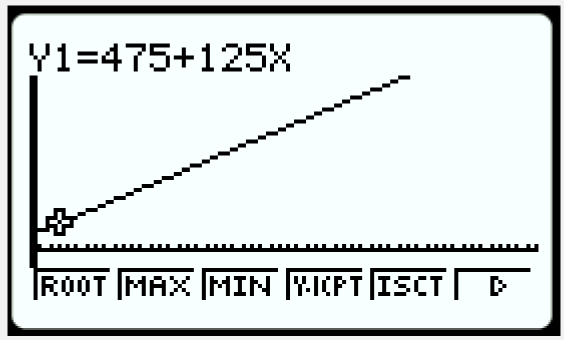
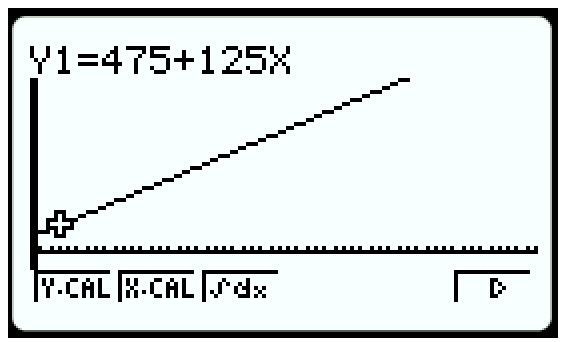
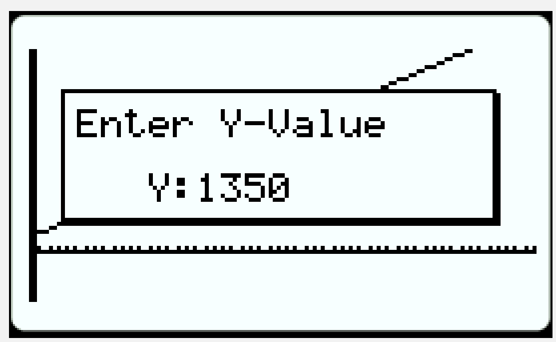


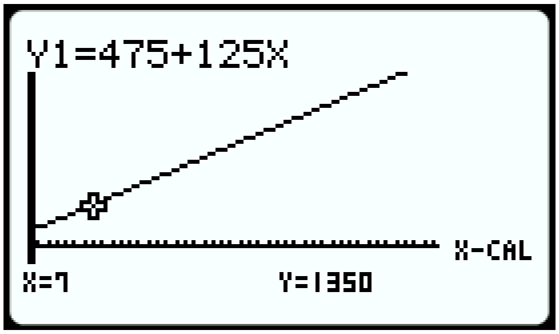
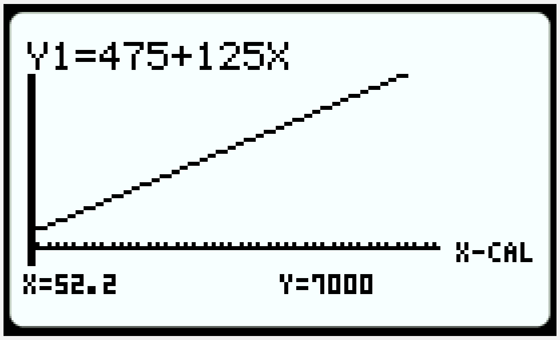
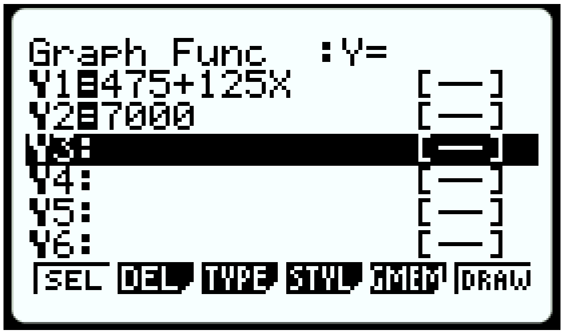
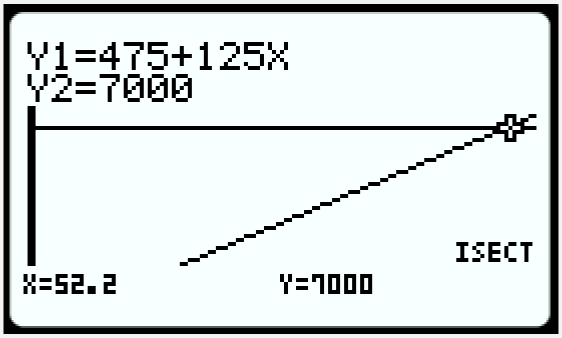
8. Now, type the numerical value for ***x*** on the keyboard that the ***y*** value is needed. This case, 3, for finding the amount in the savings account after 3 weeks.



<table>
<tr><td>9. Press [EXE] and a cross hair will be directly moved to where x=3 along with the coordinates for both x and y are displayed at the bottom of the screen. At 3 weeks, the student will have $850 in their saving account.

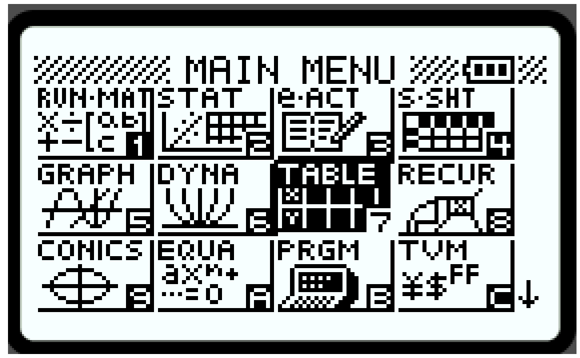
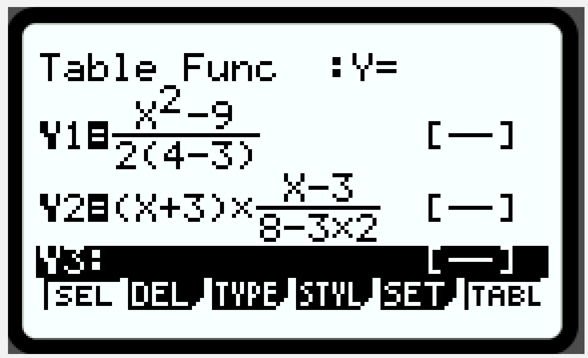
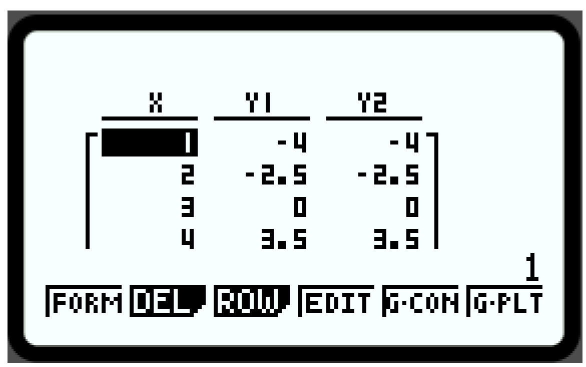
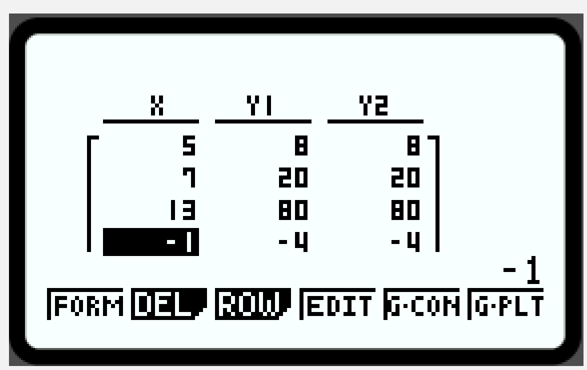
Note: The last values found for x and y are always stored for x and y within the Run/Matrix app.</td><td>
</td></tr>
<tr><td>10. The next task is to determine how long it will take before she has $1350 in her savings account. A unique way to determine this is to use the “X-Cal” tool which will calculate an x value for a given y value.

11. Press [F5] – G-Solv. The initial function keys for G-Solv are shown in the picture to the right.</td><td>
</td></tr>
<tr><td>12. Press [F6] – Next. Now we will use the X-Calculate tool by pressing [F2] – X-CAL.</td><td>
</td></tr>
<tr><td>13. Now in the pop-up window, enter the known Y-value (1350) and then press [EXE].</td><td>
</td></tr>
</table>

14. At the bottom of the screen, will be the ***x*-value** calculated for the entered ***y*-value**. So**,** for this question, the student will have $1350 in her account after 7 weeks.	
15. Lastly, we are asked to find how long will it take to reach her goal of $7000. You can follow Steps 10-14 above to use **X-Cal** to calculate the ***x*-value** when ***y*** is 7000, instead of 1350. The result is shown to the right. Since deposits are made at the end of the week, she will not have at least $7000 in her account until week 53.	
16. An alternative way of calculating ***x*-values** for a given ***y*-value** is to graph an additional equation of *y* is equal to the desired value, and then use the **Intersection Tool** from the **G-Solve** menu to find the intersection point. 17. Press EXIT to return to the graph entry window. Enter the ***y*-value** desired for **Y2**; in this case 7000. Press EXE to enter.	
18. Press F6 **– DRAW** to graph the lines. Now press F5 **– G-Solv** to see the **Graph-Solve** menu choices. Press F5 **– ISECT** to jump to the intersection point. Again, we see the same result of ***x* = 52.2** we found in Step 15.	

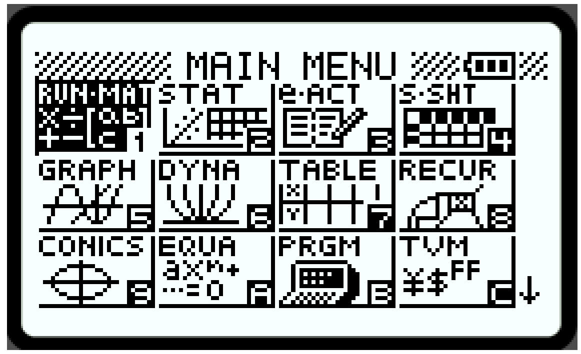
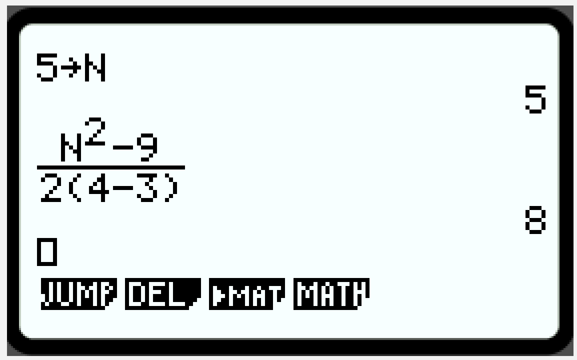
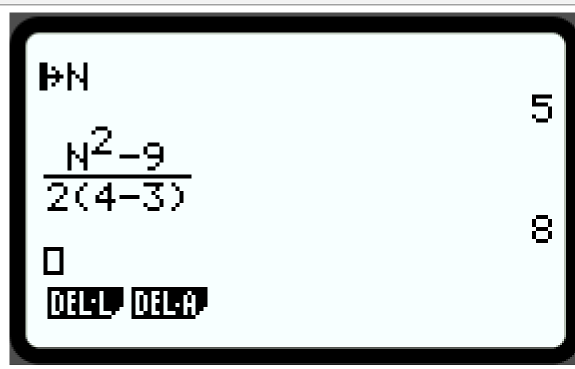
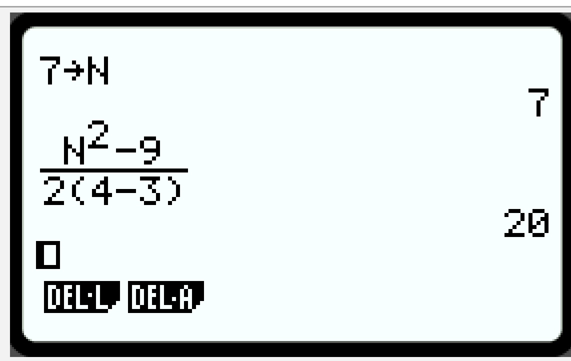
Lesson 6a – Evaluating One Variable Expressions Using a Table

(Example: IM Lesson 6.1: Two Expressions)

1. Students can quickly evaluate an expression in one variable for multiple input values by using a table. Press [MENU], [7] -  to open the Table app.	
2. Enter your expression into **Y1:** For this problem, enter in both expressions, replacing the given variable with "**X**". To get "**X**", press [X,θ,T]. To create a fraction, press  Press [EXE] when done with each expression.	
3. Press [F6]**–TABL** to view the table of values. The default values of **X** are 1, 2, 3, 4. The value of the expression for these values are listed under **Y1** and **Y2** as shown.	
4. The **X-values** can be edited to any value by highlighting one and entering the desired input value. Press [EXE], and then press [▼] to edit the next **X-value**. For our problem, we want to evaluate the expressions for inputs of 5, 7, 13, and -1 as shown to the right.	

Lesson 6b – Evaluating Expressions Using STORE in the Run/Matrix

(Example: IM Lesson 6.1: Two Expressions)

1. Students can also evaluate an expression in the Run-Matrix App by storing values for variables. This method works when there are multiple variables in an expression as well. Press [MENU], [1] – [RUN·MAT] to open the Run-Matrix app.	
2. Store the values you want to evaluate in each expression. Type the value first, then [→] followed by [ALPHA] and the key of the variable letter (N in this case is above [8]). Then, type the expression and hit [EXE] to evaluate it for the values stored above it. To create a fraction, press [fraction key].	
3. To evaluate the next value, arrow up ([▲]) four times to highlight the line where you stored the first value. Now, arrow left ([◀]) until the curser is directly behind the prior value. Press the [DEL] key so your screen matches that to the right. Now you are ready to type in the new value.	
4. Now, type the next value; 7 in this problem. Hit [EXE] and it will update the value stored in the variable, **AND** automatically update the result of all the expressions below that line <u>at the same time</u>! Continue this process, to evaluate 13 and -1.	

Lesson 8 – Using Tables to Find Outputs of a Function.

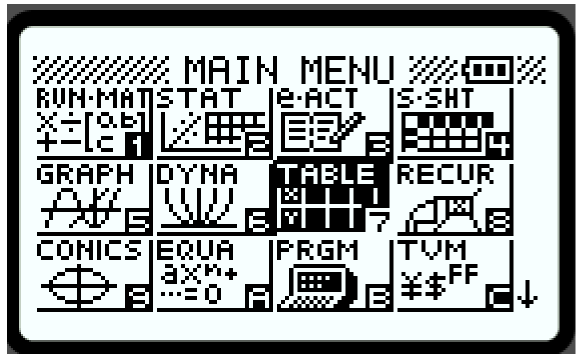
(Example: IM Practice 8.4 – Complete the Table)

<table>
<tr><td>

1. Students can quickly complete a table of a function using the Table App.

   Press [MENU], [7] – [TABLE] to open the Table app.

</td><td>

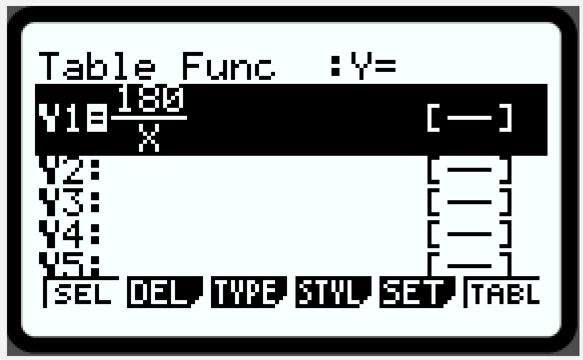


</td></tr>
<tr><td>

2. For this problem, students are asked to complete the table to determine "***r***", the rate of speed in miles per hour to travel 180 mi in "***t***" hours. Once students understand the relationship, they can enter the function in **Y1** in the Table app.

   Note: This will also make the same function **Y1** defined in the **Graph** app and for Function Variables in **Run/Matrix app**.

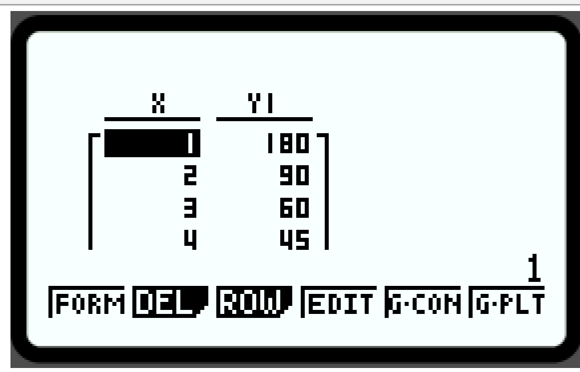
</td><td>



</td></tr>
<tr><td>

3. Next, press [F6] **–TABL** to view the table of values. The default values of **X** are 1, 2, 3, 4.

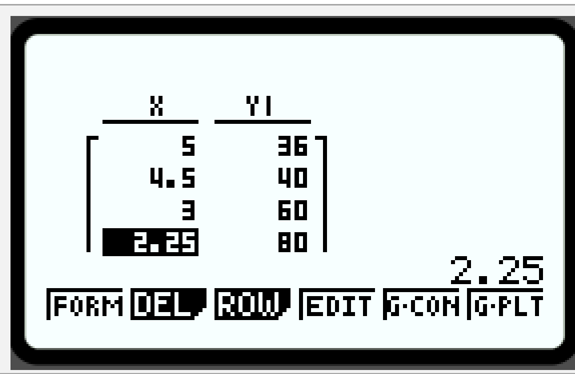
</td><td>



</td></tr>
<tr><td>

4. Now, highlight the input **X** values, and change them to the desired input values in the problem.

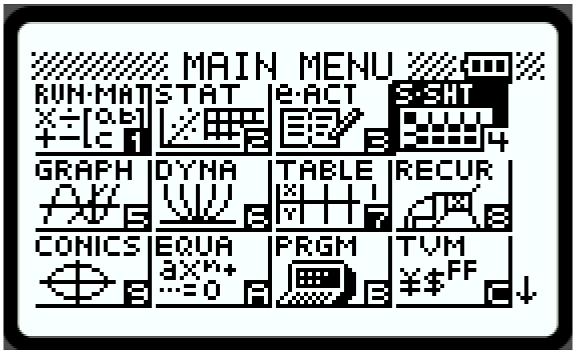
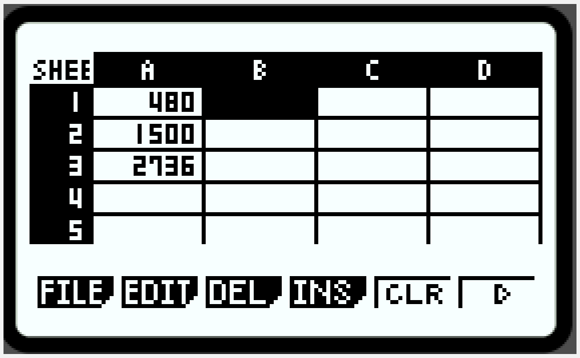
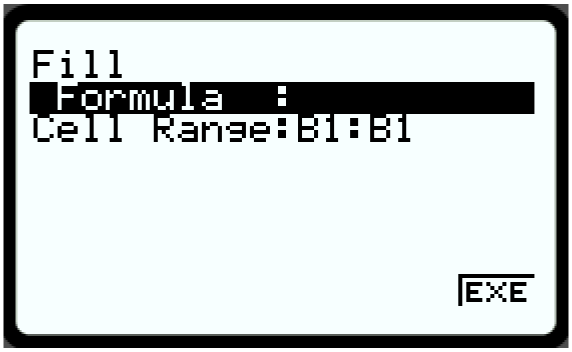
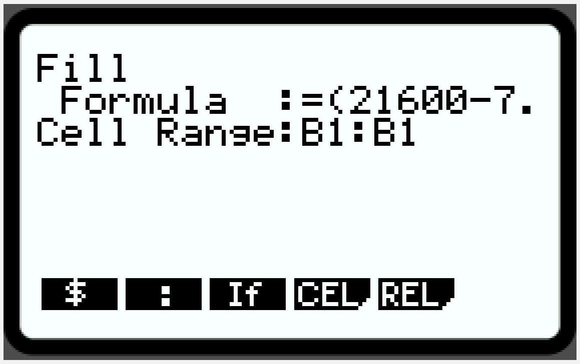
</td><td>



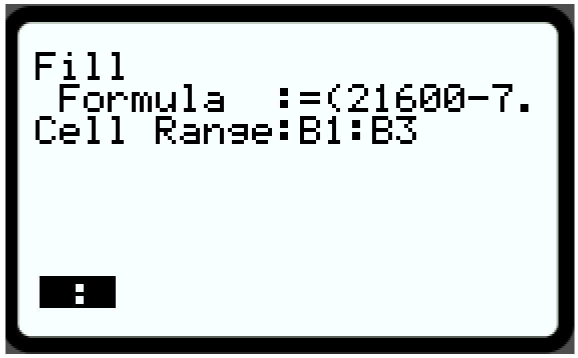
</td></tr>
</table>

Lesson 9 – Using Spreadsheets to Fill a Formula

(Example: IM Lesson 9.2: Cargo Shipping)

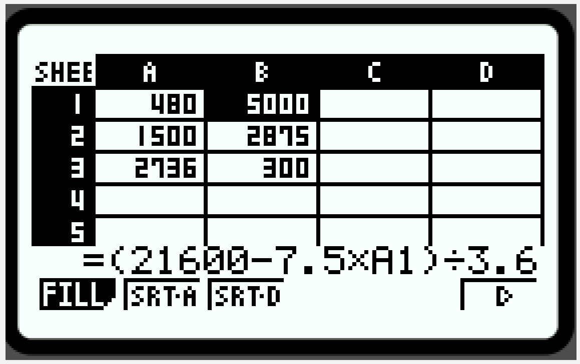
1. Students can use the graphing calculator to set u**p** and use spreadsheets. Press [MENU], [4] – [S-SHT] to open the Spreadsheet app.	
2. On the calculator, the column headings are always A, B, C, etc., while the row headings are always 1, 2, 3, etc. Entering the spreadsheet, **Cell A1** will be highlighted to enter data. For this problem, **Column A** will be the number of trucks. Enter 480 in **Cell A1** for Q2a.) and hit [EXE]. The cell moves automatically down to **Cell A2**, enter 1500 followed by [EXE] and then in **Cell A3**, enter 2736 followed by [EXE].	
3. Next, move to **Cell B1**. In this column students need to enter the expression for "***c***" found by solving their equation for "***c***" from Q1.) Use the **"FILL" Command** to enter the formula for "***c***" in Cells B1:B3. First, Press [F2] **– EDIT**, [F6] **– NEXT**, and [F2] **– FILL**.	
4. Now, enter the expression for "***c***" as the Formula. Make sure to start your formula with an **"=" sign**. For this problem, enter **=(21600-7.5*A1)/3.6** after the colon. Press [EXE] to finish.	

5. Next, press the right arrow to edit the cell range to fill. The calculator defaults to the current cell. For this problem, change **B1:B1** to **B1:B3**. Press [EXE] to finish the edit.



6. Now that the formula and cell range are complete, press [F6] **– EXE** to fill the cell range with the formula.

   For this problem, the number of cars that can be shipped are 5000, 2875 and 300.

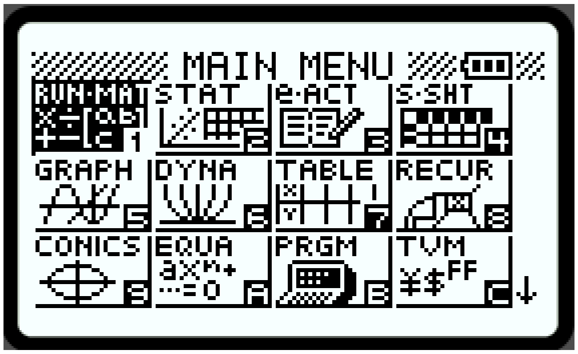


Lesson 11 – Testing if Expressions are Equivalent

(Example: IM Lesson 11.1: Rewrite These!)

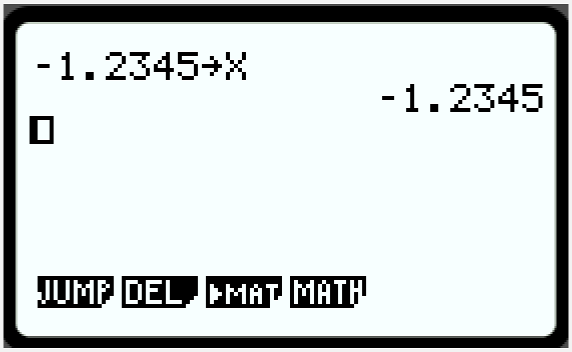
1. In this exercise, students are asked to rewrite each quotient as a sum or a difference. Students can check their answers with the graphing calculator to see if they are equivalent expressions.

   Press [MENU], [1] – RUN·MAT to open the **Run-Matrix app**.



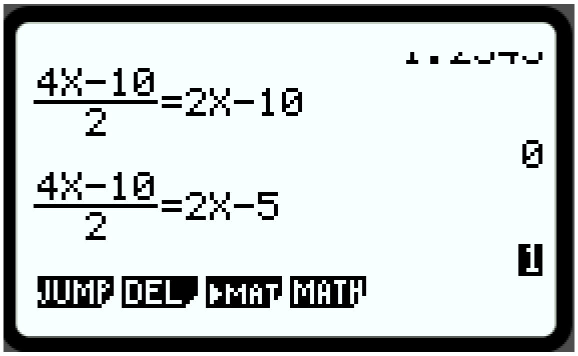
2. Equivalent expressions have equal outputs for equal inputs. Store an “ugly” value for your variable. Do this by first entering the value, then press **STORE** ([→]), the **ALPHA** button ([ALPHA]), and then the letter of the variable in the expression. Hit [EXE] to store the value in the calculator’s memory.

   Note: If there are multiple variables, store a different “ugly” value for each variable.



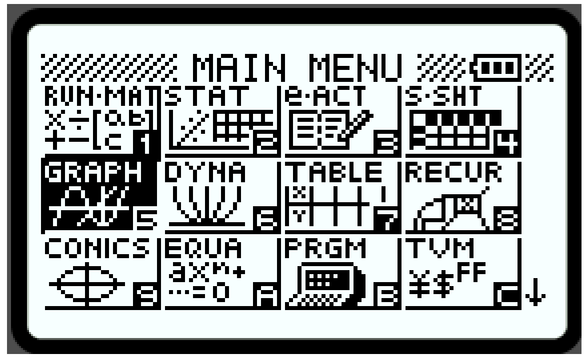
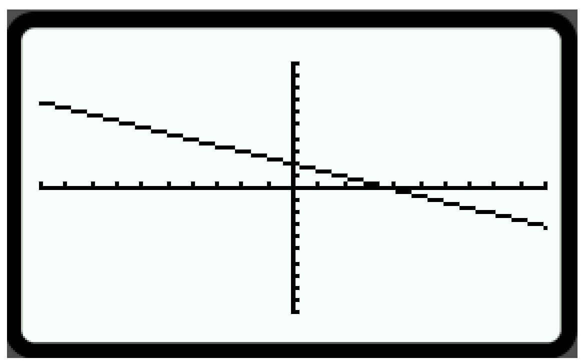
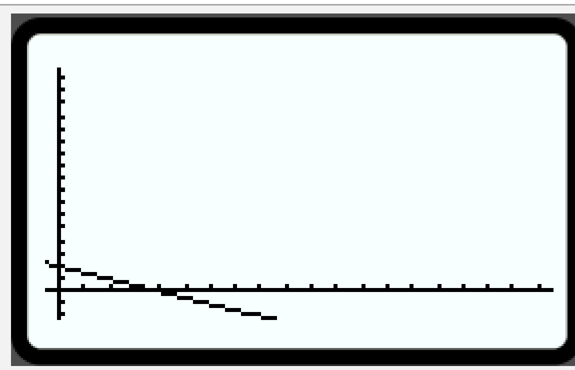
3. Next enter the original expression followed by an **equal sign** ([SHIFT] [•]) and then followed directly by the expression to test. Now press [EXE].

4. A result of **“0” (False)** means the expressions are not equivalent for the stored values, while **“1” (True)** means the expressions are equal for the stored inputs.

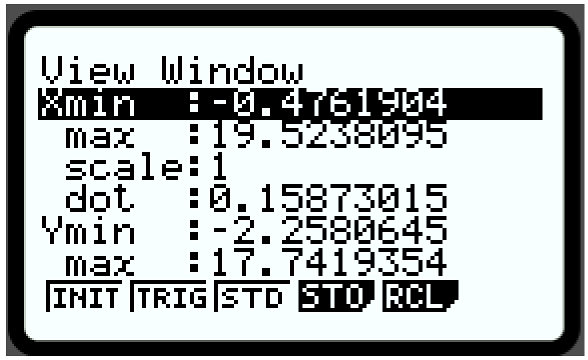


Lesson 12 – Systems of Equations Exploration – Graphs and Tables

(Example: IM Lesson 12.2: Trail Mix.)

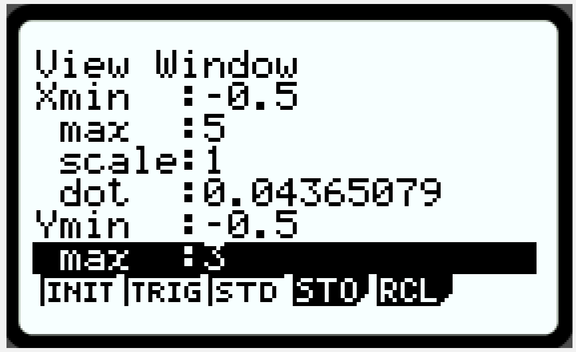
1. In this problem, students are asked to write and graph equations to represent two constraints in the same situation and use tables and graphs to see possible values that satisfy the constraints. Press [MENU], [5] – GRAPH to open the **Graph app**.	
2. Students are asked to write an equation, and graph it. Students will need to first solve for the “Y” variable of their equation. For this equation, “**Y**” represents pounds of Walnuts, while “**X**” represents pounds of Raisins. Enter the first equation in **Y1=** and press [EXE]. Note: This can be a great opportunity to discuss “equivalent expressions” from Lesson 11.	
3. Press [F6] – **DRAW** to see the graph.	
4. This window is not ideal, as the data is only valid in the first quadrant. To quickly adjust the window, you can use the directional arrows to move the graph left ◀, right ▶, up ▲, and down ▼.	

5. Next, we need to adjust the window further. Press [F3] for **V-Window**. It will show the current window view settings.

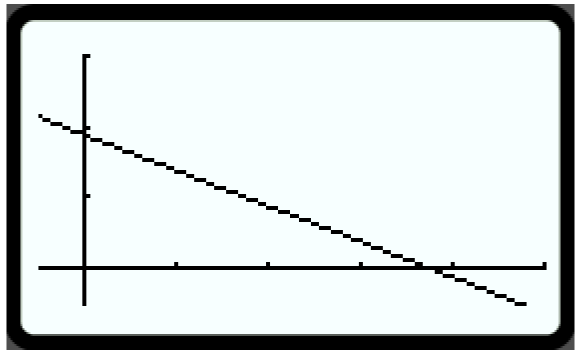


6. Adjust the values of **Xmin**, **Xmax**, **Ymin**, and **Ymax** to better utilize the screen. Enter a **Xmin** value, press [EXE], then enter a **Xmax** value and press [EXE]. Now, direction down ▼ twice to enter in a **Ymin** value, press [EXE], and finally a **Ymax** value, and press [EXE].

   Now, press [EXE] once more to return to the **Graph Entry** screen. Press [F6] – **DRAW** to see the adjusted graph window.



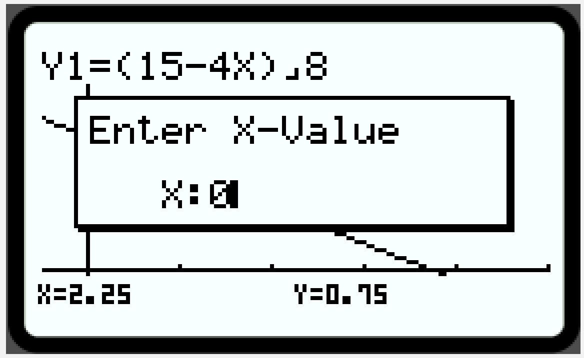
7. The next task, students are asked to complete missing parts of a table. For missing outputs (**Y-values**), students can utilize the instructions for Lesson 8 – Using Tables to Find Outputs of a Function. In this case, we also have missing inputs (**X-values**) to find for given **Y-values**.

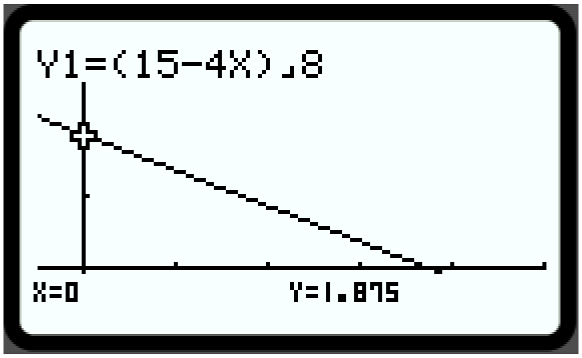
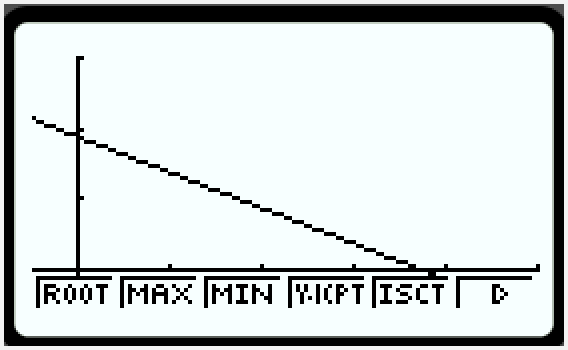
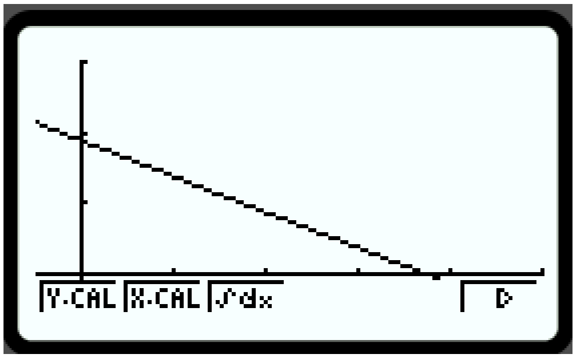
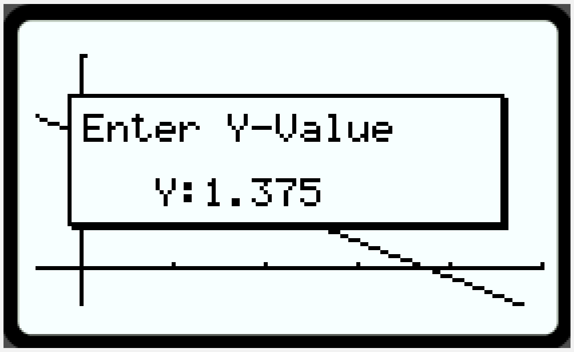


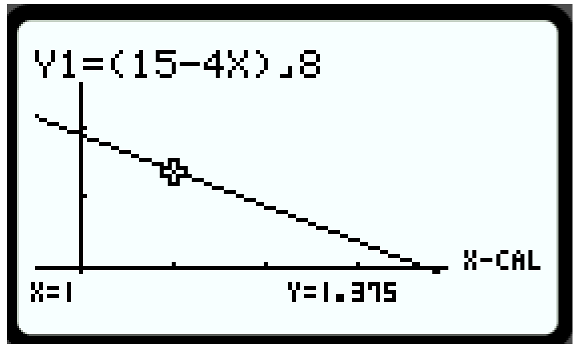
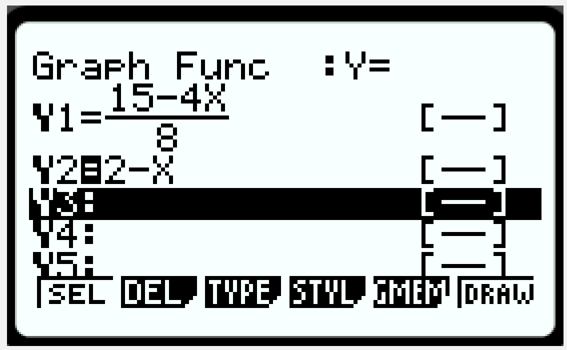
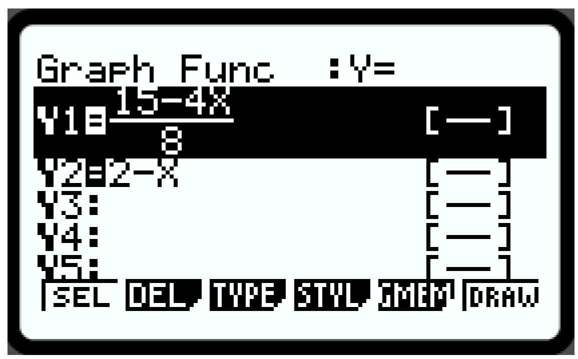
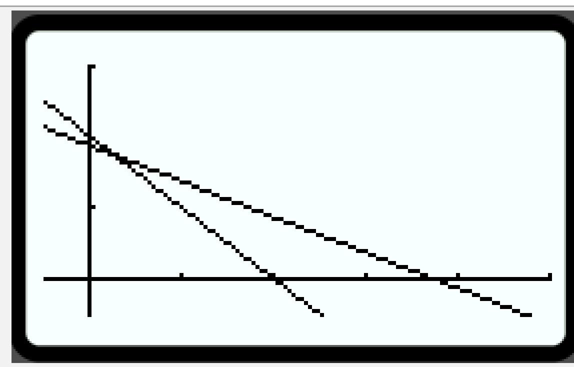
8. The **TRACE** function can quickly find missing outputs (**Y**) for a given input (**X**).

   Press [F1] – **TRCE**. A point on your graph will be highlighted with a cross-hair, and the coordinates of the point are shown at the bottom of the screen.

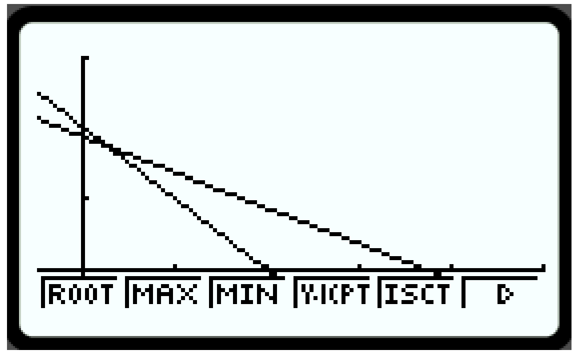
   Using the number pad, type the value of the **X-value** and then [EXE] to quickly jump to that next exact location.



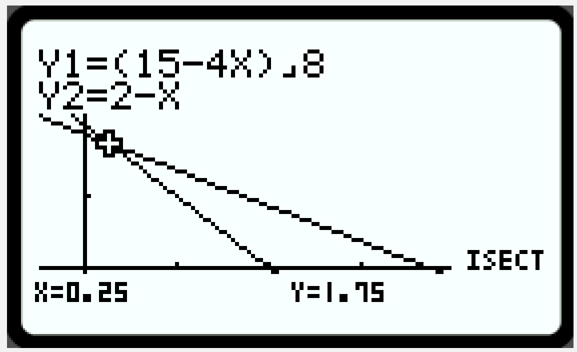
9. Use the number pad to type in your next ***x*-value** from your table and hit EXE to move to that point on your graph. Repeat until all the ***y*-values** are found for each given ***x*-value** in the table.	
10. To find missing ***x*-values** in our table for given ***y*-values**, we will use the **Graph-Solve** utility. Press F5 **– G-Solv**. The initial function keys for **G-Solv** are shown in the picture to the right.	
11. Press F6 **– Next**. Now we will use the **X-Calculate** utility by pressing F2 **– X-CAL**.	
12. Now, enter the given Y-value and then press EXE.	

13. Repeat for other ***y*-values** in the table, to calculate their ***x*-value** inputs. When completed, press [EXIT] to return to the graph entry window.	
14. In **Y2**, enter your second equation which represents the total of 2 pounds of weight. The graph of **Y1** can be “Unselected” by highlighting it and pressing [F1] – **SEL**. The equal sign will now not be highlighted. (See picture to the right) 15. Repeat Steps 2-13 for this second equation.	
16. Now, graph the system of equations at the same time. From the graph entry window, re-select **Y1** by arrowing up to highlighting it and pressing [F1] **– SEL**. Both **Y1** and **Y2** will have their equal signs highlighted and now will be graphed simultaneously.	
17. Press [F6] **– DRAW** to plot both graphs on the same set of axes.	

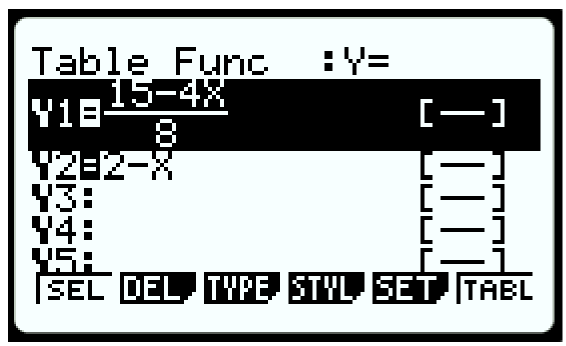
18. The point of intersection makes both criteria true. Press F5 – **G-SOLV** to view the **graph-solve** menu.



19. Again, press F5 **– ISCT** to view the point of intersection. The first (and only) intersection point will be shown on the graph with the ***x* and *y*-coordinates** displayed at the bottom of the screen.

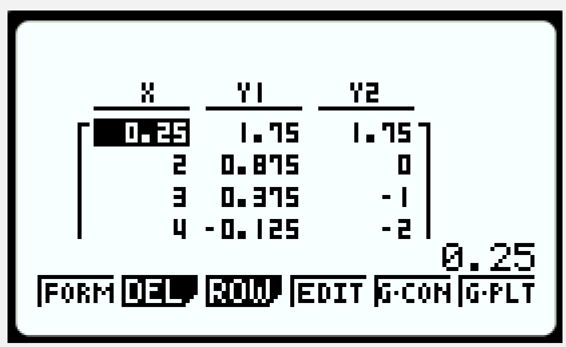


20. The **Table App** can also be used to verify an intersection point. Press MENU, 7 – TABLE to open the **Table App**. Any functions entered in the **Graph App** are automatically stored in the **Table App**.



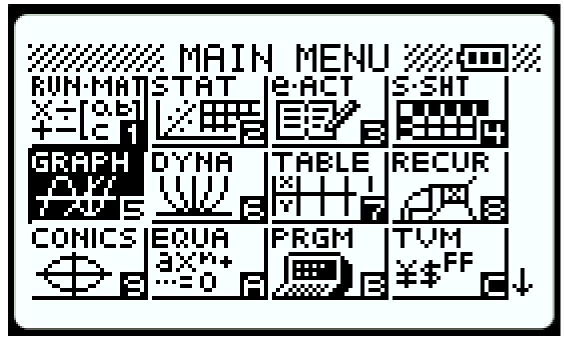
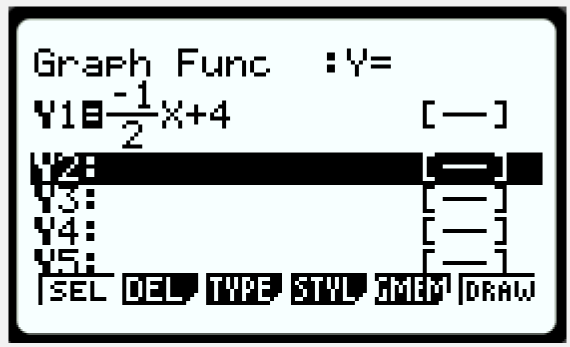
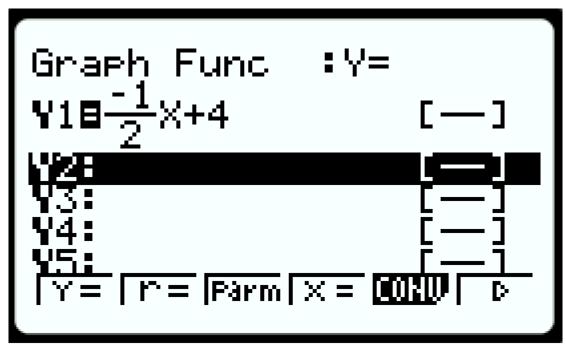
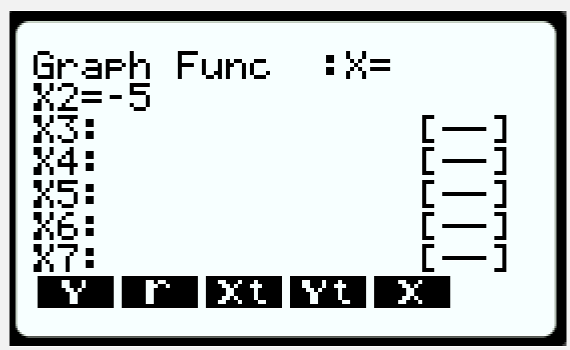
21. Press F6 **– TABL** to view the tables for both criteria. The inputs, **X**, can be edited directly in the table. Highlighted values can be changed. Change 1 to 0.25, then press EXE. Now it can be seen that **Y1** and **Y2** both have an output of 1.75.

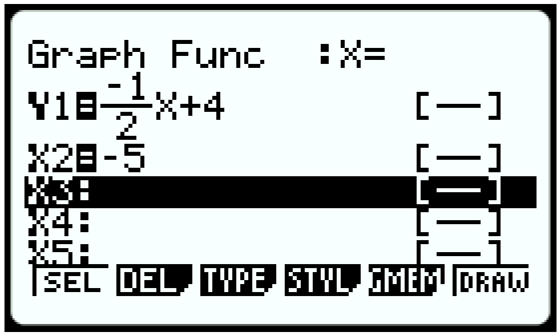
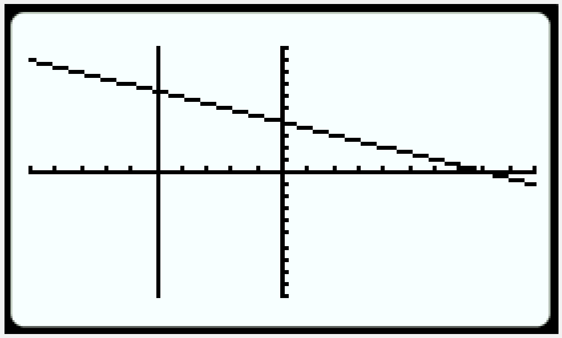
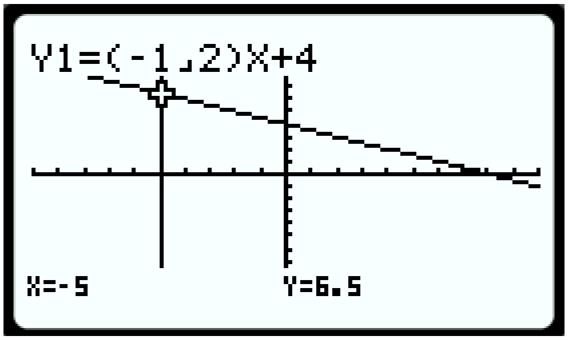
22. Now we saw on the graph and verified in the table that for both criteria to be true, ¼ lb. of Raisins and 1¾ lb**s.** of Walnuts were purchased to create this batch of Trail Mix.



Lesson 13a – Graphically Solving Systems Involving a Vertical Line

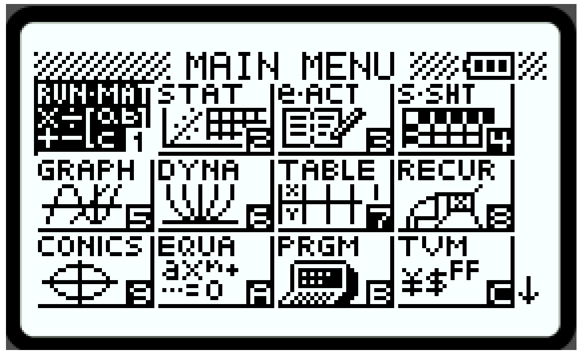
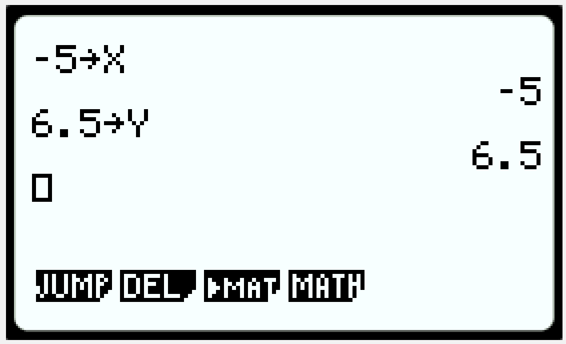
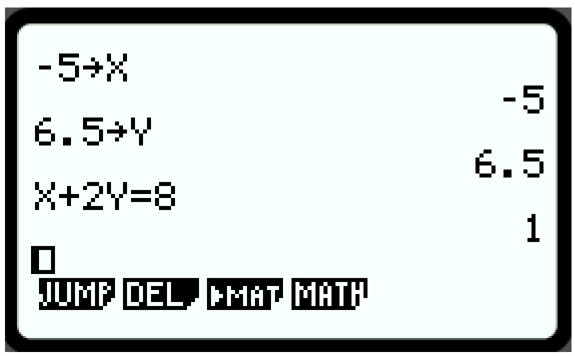
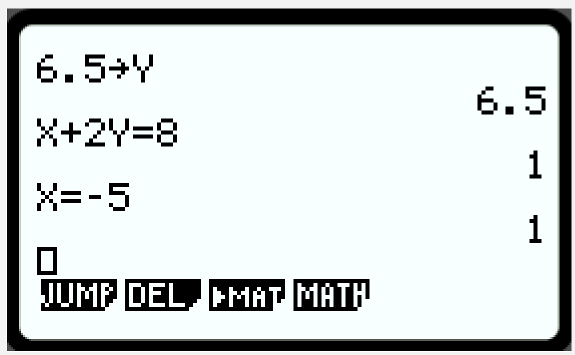
(Example: IM Lesson 13.2: Four Systems)

1. Students are tasked with solving four systems of equations. At this point in Unit 2, many students may still utilize solving the systems graphically to find solutions. Since this is an introduction to solving algebraically by substitution, these systems involve vertical and horizontal lines. Press [MENU], [5] - GRAPH to open the Graph app.	
2. To graph linear equations, the equations need to be rearranged to solve for "**Y**"; in most cases. In addition, equations can be solved for "**X**" as well; usually for vertical lines. The first system is x + 2y = 8 and x = -5. Solve for **y** in the first equation and enter in **Y1**. Use [X,θ,T] for "**X**", and [ALPHA] [(-)] for "**Y**".	
3. Press [EXE] when **Y1** is complete. Now you will be ready to enter the second equation; ***x*=-5**. Press [F3] **– TYPE** to change the type of graph.	
4. Now, press [F4] **– X=**. This will change the graph entry from **Y2:** to **X2:** so ***x*=-5** can be graphed. Repeat steps 3 & 4 to return to **Y=** . Note: the function buttons ([F1] - [F5]) are for entering prior graph types stored as part of your new graph.	

5. Enter -5, then press EXE.	
6. To view the graph, press F6 **– DRAW**.	
7. From the graph, we can visibly see that the graphs cross when ***x*=-5**. To find the ***y*-value**, press F1 for Trace. Using the number pad, enter -5 then EXE. The coordinates of the solution of this system are shown; ***x* = -5**, ***y* = 6.5**.	

Lesson 13b – Testing Solutions to Systems of Equations

(Example: IM Lesson 13.2: Four Systems)

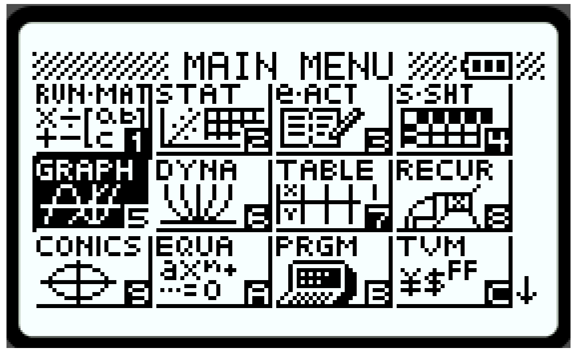
1. After solving a system of equations, either graphically or algebraically, the solutions can be tested to know if they make each equation either **true (1)** or **false (0)**. This is done in the **Run-Matrix App**. Press [MENU], [1] – [RUN-MAT] to open the **Run-Matrix app.**	
2. In Lesson 13a, we found a solution to the system of ***x* + 2*y* = 8** and ***x* = -5** to be the point **(-5, 6.5)**. First, we will use the **STORE** command to store the solutions for "**X**" and "**Y**". First, enter the numerical value to be stored, then press [→] followed by [ALPHA] and the letter of the variable in your equation. Press [EXE] to store the value in memory. (For "X", you can quickly use the [X,θ,T] button instead.)	
3. Now, type in each equation. To enter the equal sign, press [SHIFT] then [•]. Once you finish the 1st equation, press [EXE]. A result of 1, as shown, means that the equation is true.	
4. Repeat Step 3 for the second equation. Since these values made **both** equations true; result of 1; they are the solutions to our systems of equations. 5. If either equation resulted in 0 in our test, the values being tested do not make the equation(s) true, so they would not be a solution to the system of equations indicating to double check the algebraic work completed in finding those solutions.	

Lesson 14 – Investigating Adding or Subtracting Equations to Solve Systems of Equations.

(Example: IM Lesson 14.3 – Adding and Subtracting Equations to Solve Systems)

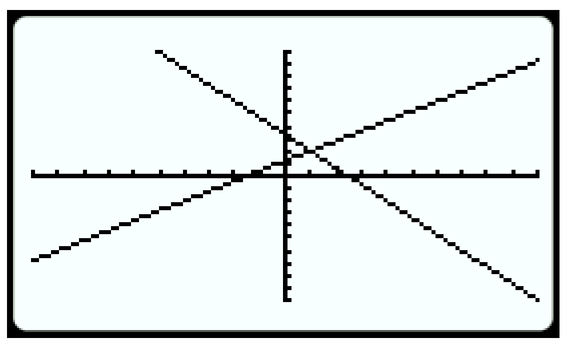
1. In this activity, students will review solving systems graphically, and investigate what a third equation; the sum or difference of their systems; has in common. We will be using their graphs for this investigation.

   Press MENU, 5 – GRAPH to open the **Graph app**.

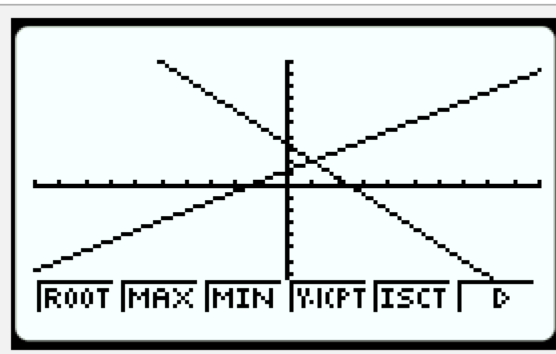


2. Solve each of the original standard form equations for ***y*** to enter the two equations for **Y1** and **Y2**. For System A, solving for ***y*** yields the equations in the picture to the right. Remember to use the X,θ,T button to quickly enter ***x*** in the equations.

3. Once both equations are entered for **Y1** and **Y2**, press F6 **– DRAW** to display their graphs.

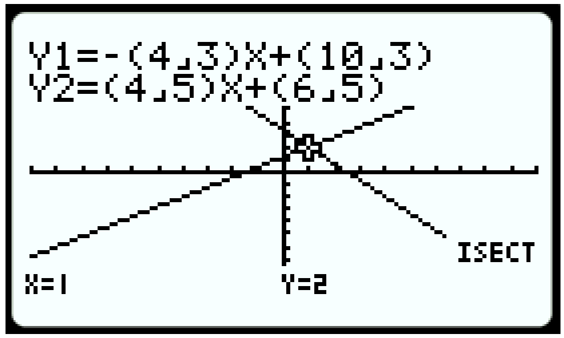


4. Next we are asked to identify the coordinates of the solution. This will be where the equations intersect. To find the intersection point, press F5 **– G-Solv**, to view the **Graph Solve** function menu, shown to the right.

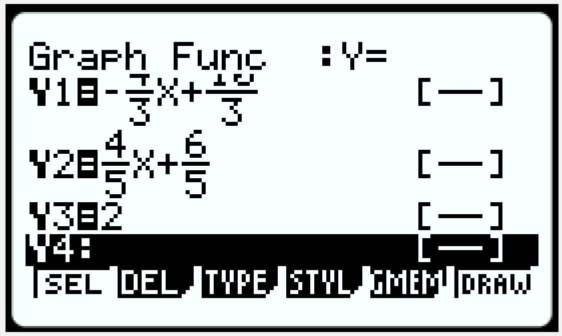


5. Now press F5 again **(ISCT)**, to display the intersection point along with the equations of the lines. For **System A**, the solution to the system is (1, 2).

   Note: To maximize the graph display area, the fractions are always displayed here in **Linear display mode** regardless of **Input/Output** choice in the **Settings menu**.

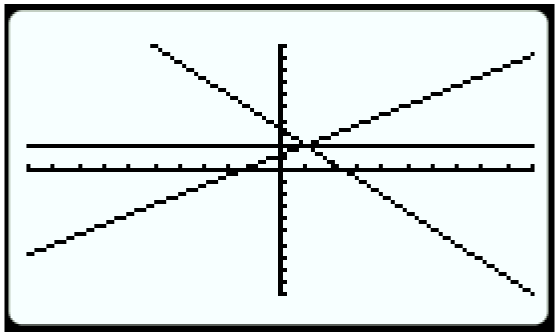


6. The next task is to find either the sum or difference of the two original equations that would enable the system to be solved. For **System A**, the sum of the equations would yield **8y = 16**; as the ***x*-variable terms** have **opposite coefficients**. Solving for ***y*** gives us a third equation, **y = 2**. For **Y3**, enter 2 to graph the third equation. Press EXE.



7. The final task for this problem is to graph the third equation and make an observation about the graph. Press F6 **– DRAW** to display all three graphs on the same coordinate grid.

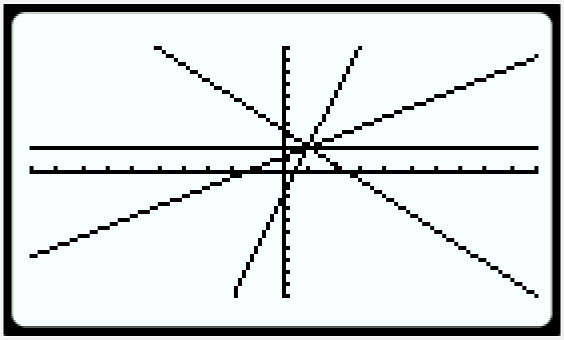
8. As shown to the right; it should be observed that all three equations cross at the same point, reinforcing the concept that new equations created from a system of equations have the same solutions.



9. To further support this conclusion, let's graph a fourth equation. Press EXIT to return to the graph entry window.

10. We used the **sum** of the original equations in Step 6. For **Y4**, graph the **difference** of the original equations. For **System A**, the difference would be the equation **8x – 2y = 4**. Solving for y to enter into **Y4** we have **y = 4x – 2**.

11. Notice that all four equations cross at the same point, **(1,2)**, the solution to the original system of equations.

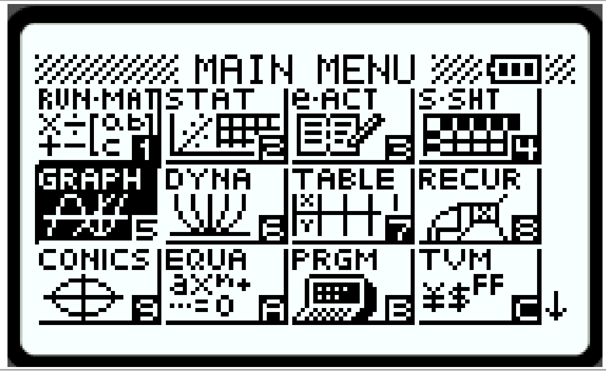


Lesson 15 – Solving Systems by Elimination: A Word Problem.

(Example: IM Lesson 15.2: Classroom Supplies)

1. This lesson will be a review of solving systems graphically along with reenforcing the idea of creating “new” equations share a solution with the original system.

   Press MENU, 5 – GRAPH to open the **Graph app**.



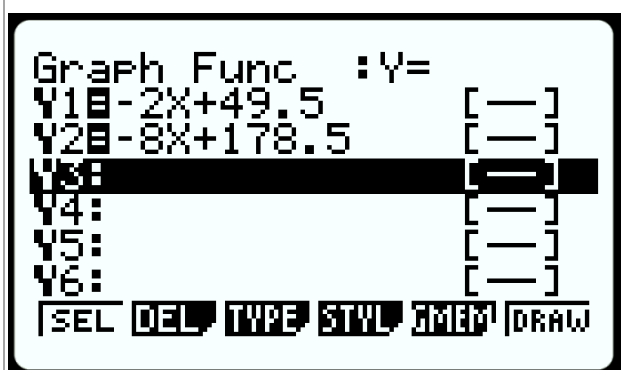
2. This problem is modeling a situation where a teacher purchases different amounts of classroom supplies of calculators and tape measures. First, 20 calculators and 10 measuring tapes were ordered costing $495. She then placed an additional order of 8 more calculators and 1 additional tape measure costing $178.50.

3. Letting ***x*** be the unit price of a calculator and ***y*** represent the unit price of a measuring tape, the above situation can be modelled using the system of equations.

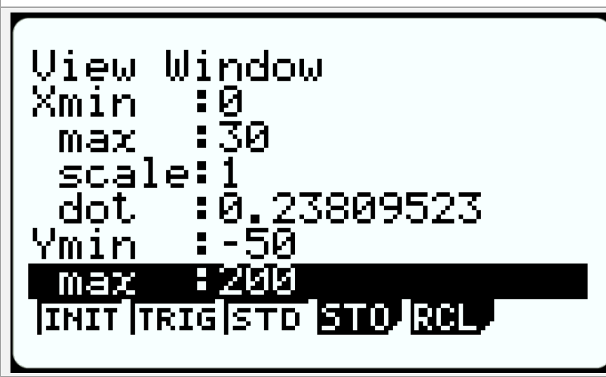
   $$20x + 10y = 495$$
   $$8x + y = 178.5$$

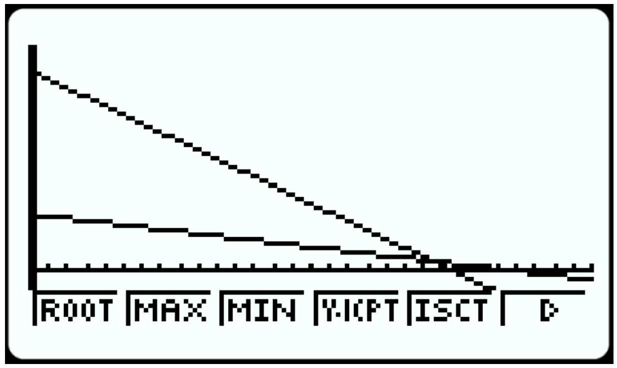
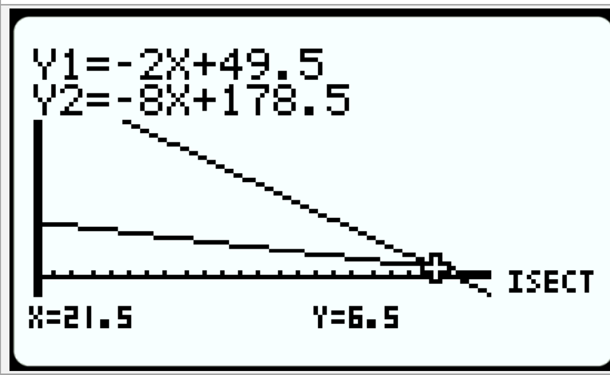
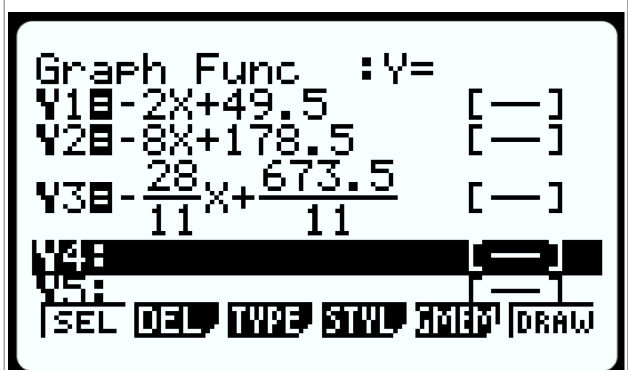
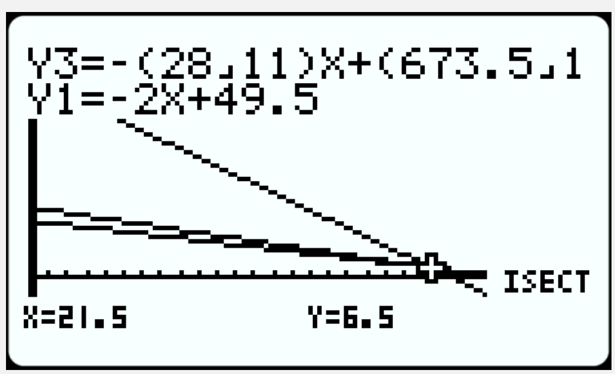
   To graph this system, solve for ***y*** in each equation, and enter for **Y1** and **Y2**. Press X,θ,T button to obtain the variable ***x***.

   $$y = -2x + 49.5$$
   $$y = -8x + 178.5$$



4. After entering the equations, the window will need to be adjusted to best view this system. Press SHIFT, F3 – **V-Win**. In slope-intercept form, we see the ***y*-intercepts** clearly. From these values, an appropriate scale for the ***y*-axis** would be -50 to 200. For the ***x*-axis**, we may need to experiment to obtain a usable window. 0 to 30 allows us to view the point of intersection in our viewing window. Press EXIT to return to the graph entry window.



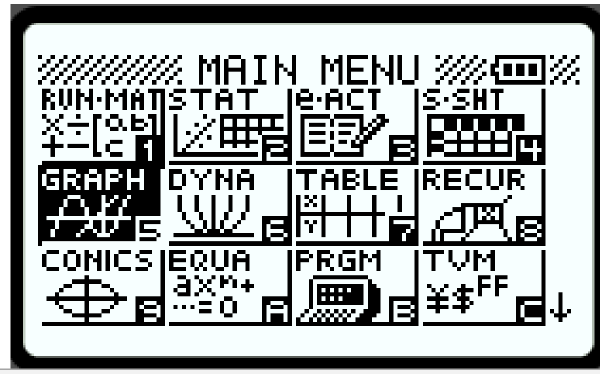
5. Now, press F6 **– DRAW** to view the graph. To find the point of intersection graphically, press F5 **– G-Solv**, to view the **Graph Solve menu**.	
6. Now press F5 again (**ISCT**), to display the intersection point along with the equations of the two lines. The lines cross when ***x* = 21.5** and ***y* = 6.5**. In the context of our problem, this relates to a unit price for a calculator to be $21.50 and each measuring tape costs $6.50. (Note: Setting the **Ymin** at -50 allowed us to still see the graph intersection and the coordinates at the bottom of the screen at the same time.) Press EXIT to return to the graph entry window.	
7. The remaining task, in this part of the lesson, is to consider what would happen if the teacher ordered **all** the supplies at once. Students are asked to predict what all three equations would look like when graphed. In total, 28 calculators and 11 tape measures for a total cost of $673.50. This can be written as an equation as: 28***x*** + 11***y*** = 673.5 Solve for ***y*** and enter for **Y3**. ***y*** = -(28/11)***x*** + (673.5/11)	
8. Press F6 **– DRAW** to view all 3 graphs. It should be noted that all 3 equations cross at the same point found earlier, verifying that the unit prices; our solution to the system; did not change when we added the equations together.	

Lesson 16 – Investigating Multiplying an Equation by a Constant to Solve Systems of Equations.

(Example: IM Lesson 16.2: Writing a New System to Solve a Given System)

1. This task is designed for the teacher to demonstrate during the lesson. We will be graphing equations derived from a system of equations. Students should learn that each time we perform a move that creates one or more new equations, we are in fact creating a new system that is equivalent to the original system.

   Press MENU, 5 – GRAPH to open the **Graph app**.

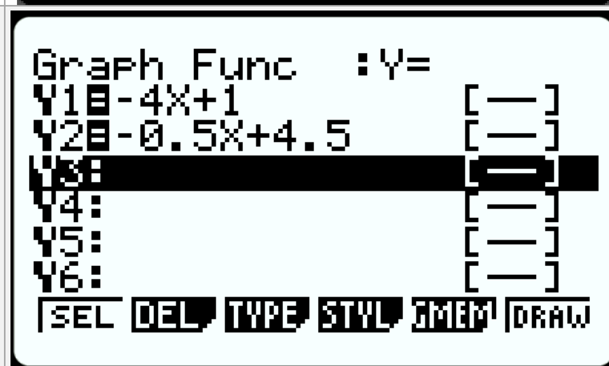


2. Students will start with a system they solved by graphing earlier.

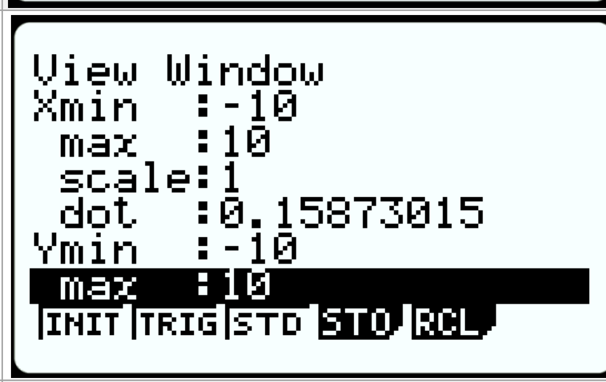
   Equation A $4x + \ \ y = 1$
   Equation B $\ \ x + 2y = 9$

   Solve both for y and enter for **Y1** and **Y2**. Use the X,θ,T button to enter the x in both equations.

   Equation A $y = -4x + 1$
   Equation B $y = -0.5x + 4.5$



3. A standard window will work nicely for this system. Press F3 **– V-Window** to either adjust a window manually or choose a preset window. For this system, choose the preset “Standard” window by pressing F3 a second time to choose **STD**. This will automatically set a -10 to 10 window for both the x and y **axes**. Press EXIT to return to the graph entry window.



4. Next, an example is shown to the students of how someone solved this system algebraically by multiplying Equation B by 4 and then subtracting the two equations.

   To solve the system, Elena wrote:

   $4x + \ \ y = 1$
   $4x + 8y = 36$

   And then wrote:

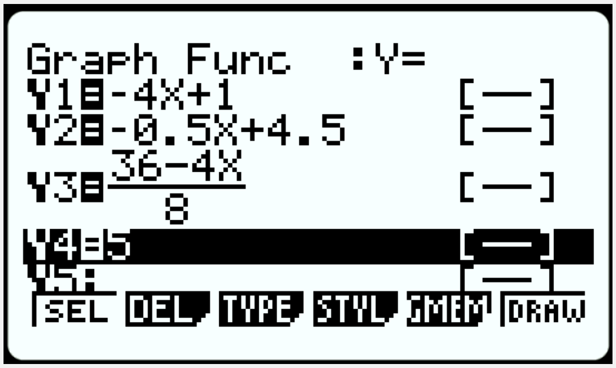
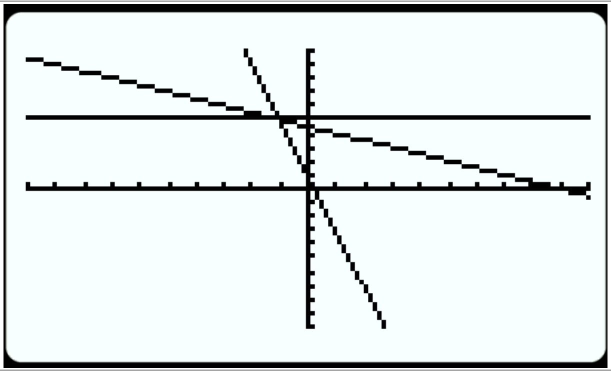
   $4x + \ \ y = 1$
   $4x + 8y = 36\ -$
   $-7y = -35$

5. Students are then asked a couple questions.

   1.) What were Elena’s first two moves? What might be possible reasons for these moves?

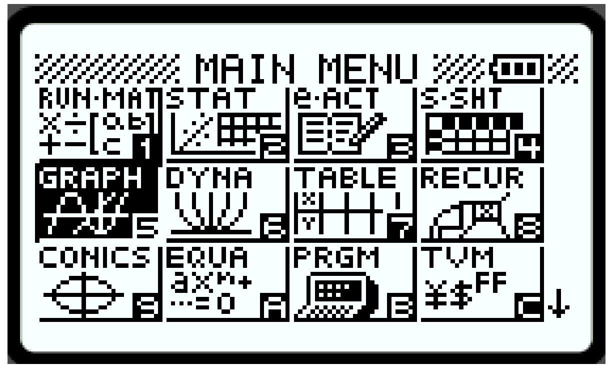
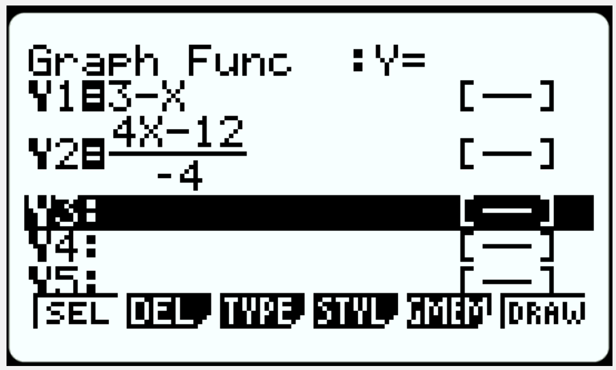
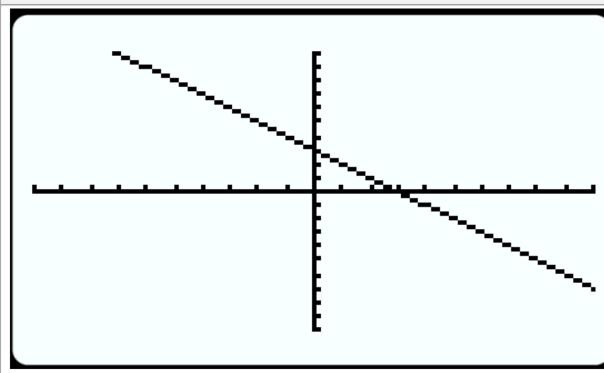
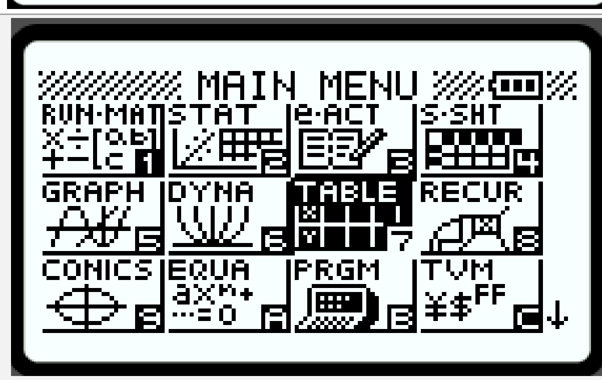
   2.) Complete the solving process algebraically. Show that the solution is indeed x = -1, y = 5.

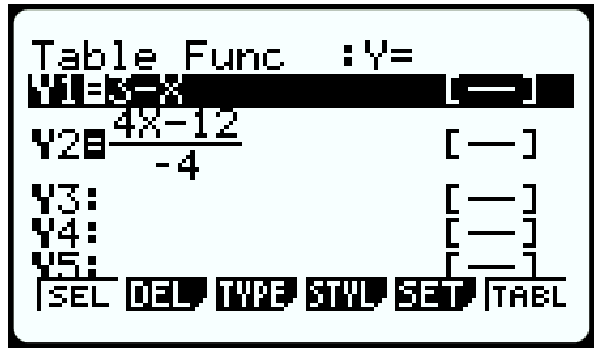
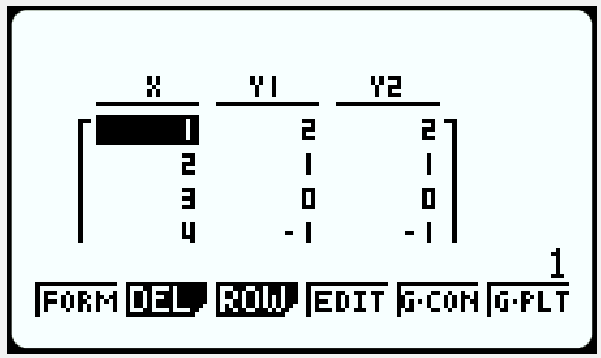
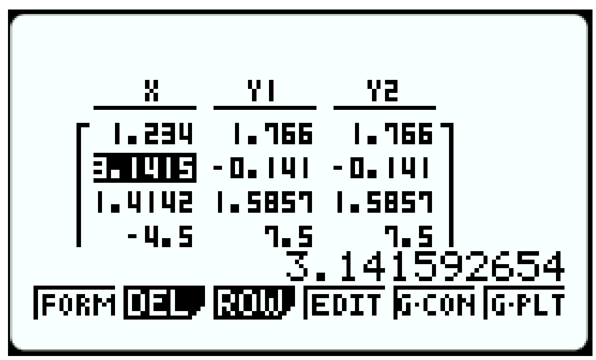
   Note From IM: Some students may be confused about the subtraction symbol after the second equation. Encourage then to ignore the sign at first, find the relationship between the three equations, and then think about what the sign means.

6. **From IM: Display for all to see the two original equations in the system and the new equations Elena wrote:** 4***x*** + 8**y** = 36 and -7***y*** = -35 7. Isolate ***y*** and enter the graphs into **Y3** and **Y4**. (Example shown to the right) **Note:** when solving for ***y*** in Elena's first equation, students should see that the result is identical to **Y2**, (***y*** = -0.5***x*** + 4.5) and thus does not add an additional graph to the display as **Y2** and **Y3** are equivalent equations. **Y4**, (***y* = 5**) will add a horizontal line that goes through the solution point of the original system of equations.	
8. Press [F6] **– DRAW** to view the graphs. Students' attention is then focused on how the original equations were altered to create equivalent systems – systems with the exact same solution set. One way to create an equivalent system is to multiply one or both complete equations by a factor. The factor should be strategically chosen to create coefficients that will eliminate one variable when the resulting equations are either added or subtracted.	

Lesson 17a – Graphing a Systems of Equations with Infinite Solutions

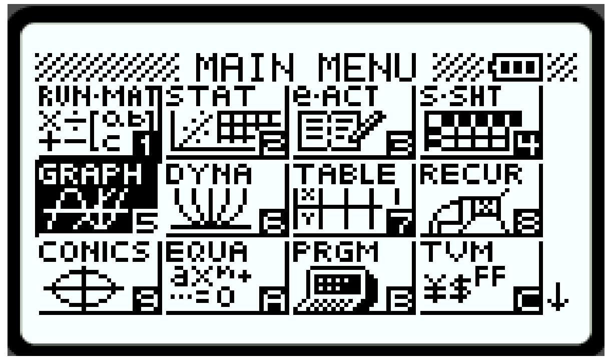
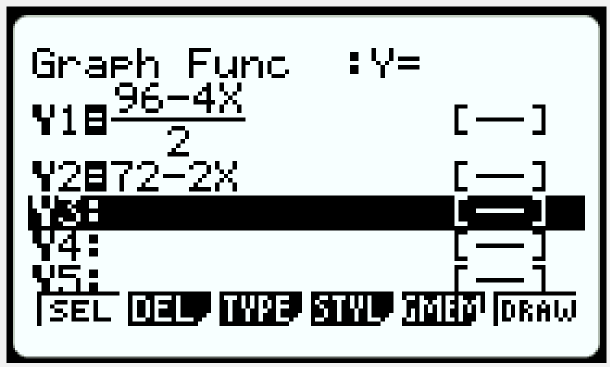
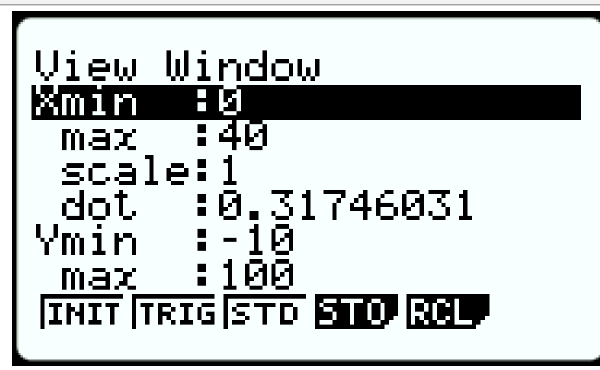
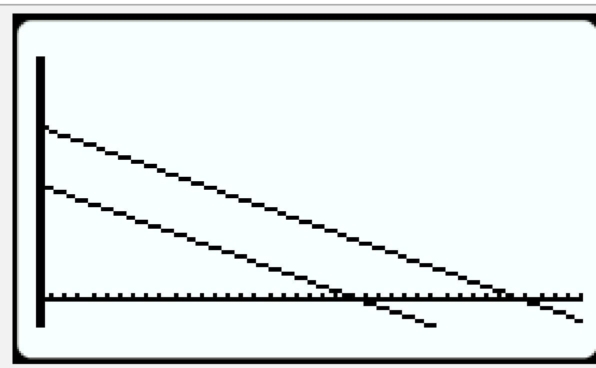
(Example: IM Lesson 17.1: A Curious System)

1. In this exercise, students will encounter a system of equations where there are infinite solutions. Let's look at this type of system graphically. Press MENU, 5 – GRAPH to open the **Graph app**.	
2. We are first asked to solve Andre's system of equations. His system is: $x + y = 3$ $4x = 12 - 4y$ Solving both equations for ***y*** will reveal that they are equivalent equations if simplified completely. However, not all students will realize that initially. Instead, let's graph a non-simplified version of this system. Enter the following equations for **Y1** and **Y2**. **Y1** = 3 – ***x*** **Y2** = (4***x*** – 12)/(-4)	
3. Press F6 – **DRAW** to view the graphs. Since they are equivalent equations, the graphs will be the same line, so all the points on the line are solutions to the system.	
4. To further emphasize this; we can view the table for this system. Press MENU, 7 – TABLE to open the **Table App**.	

5. The equations entered in the **Graph App** are automatically saved in the **Table App**.	
6. Press F6 -**TABL** to view the table of values. The default values of **X** are 1, 2, 3, 4. The value of the expression for these values are listed under **Y1** and **Y2** as shown.	
7. Now, highlight an ***x*-value**, and change it to any number desired. For any input, **X**; **Y1** and **Y2** will remain equal values, meaning there are an infinite number of solutions to this system.	

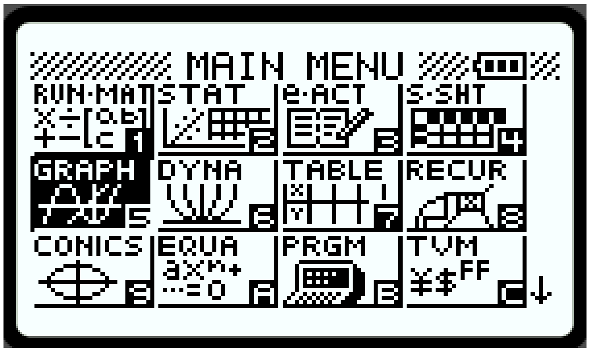
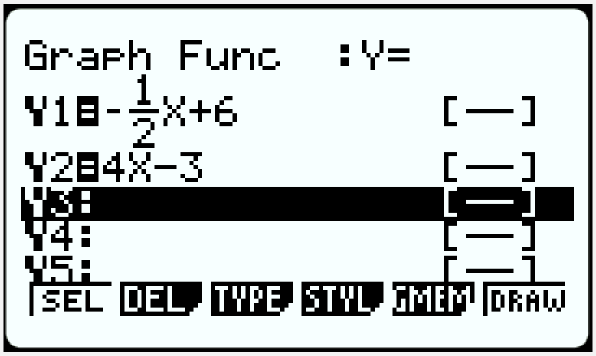
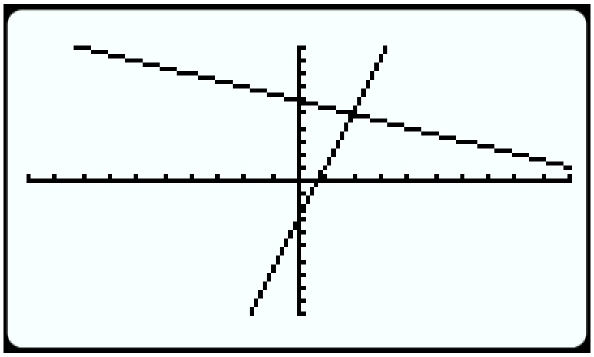
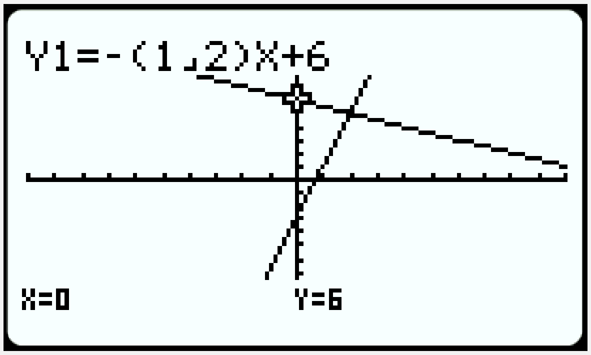
Lesson 17b – Graphing a Systems of Equations with No Solutions

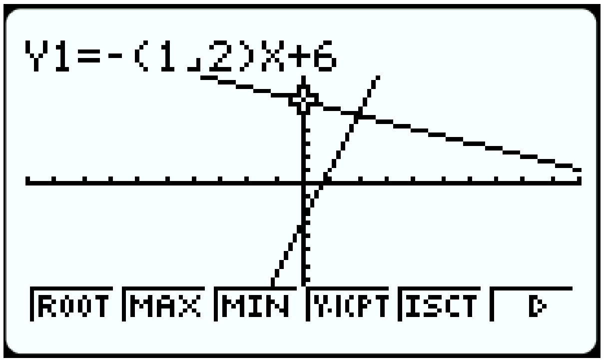
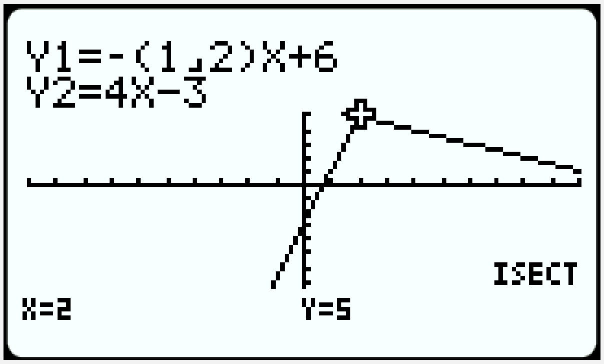
(Example: IM Lesson 17.2: What's the Deal?)

1. In this exercise, students will encounter a system of equations where there are no solutions. Let's look at this type of system graphically. Press [MENU], [5] – [GRAPH] to open the **Graph app**.	
2. The problem in this exercise deals with purchasing pool passes and gym memberships. The situation given yields a system of equations where ***p*** is the cost of a pool pass and ***g*** is the cost of a gym membership: $4p + 2g = 96$ $2p + 1g = 72$ Exchanging ***p*** for ***x*** and ***g*** for ***y*** we can graph these on the calculator. Solve each for **y** and enter into **Y1** and **Y2** as shown to the right.	
3. Especially in real world problems, the scaling of the axes will need to be adjusted to view the graphs properly. 4. Press [SHIFT] then [F3] for **V-Win**. From these values, an appropriate scale for the ***y*-axis** would be -10 to 100. For the ***x*-axis**, we may need to experiment to obtain a usable window. 0 to 40 allows us to view both ***x*-intercepts** of our system as well.	
5. Press [EXIT] to return to the graph entry window and then press [F6] **– DRAW** to view the graphs. Since the lines have **equal slopes**, but have different **y-intercepts**, they will never cross. So**,** for this system there are **no solutions** as there are no points that are on both lines simultaneously.	

Lesson 19 – Graphing to Find Solutions to One Variable Inequalities

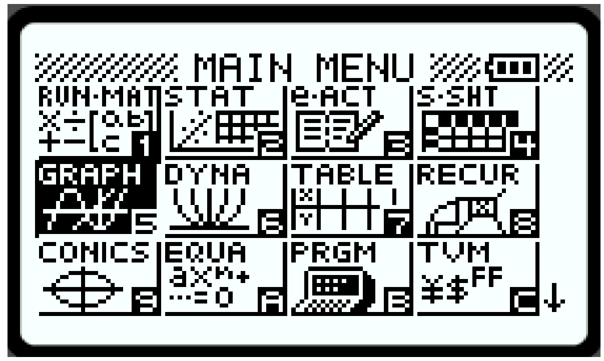
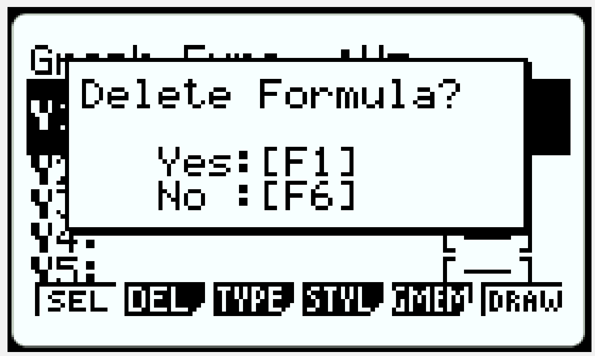
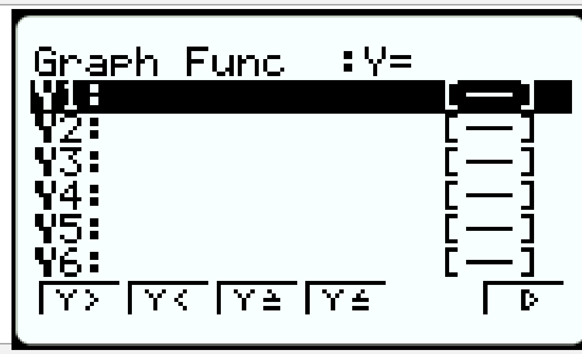
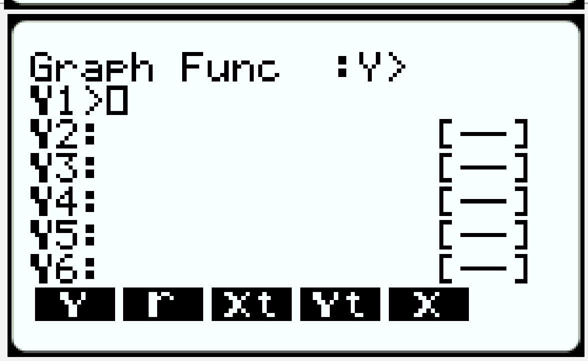
(Example: IM Optional Activity - Lesson 19.5: More or Less?)

1. This activity allows students to visualize an inequality in one variable in another way; by graphing the expressions on each side of the inequality and determining which side of the intersect makes the inequality true. Press [MENU], [5] – [GRAPH] to open the **Graph app**.	
2. The example inequality for this exercise is **– ½ *x* + 6 < 4*x* – 3** Graph the left side of the inequality for **Y1** and the right side of the inequality for **Y2**. Remember to use the [X,θ,T] button to enter the ***x*** in the equations and press [EXE] once each expression is fully entered.	
3. Now press [F6] **– DRAW** to view the two graphs. These graphs fit nicely in a Standard Window. Since we desire for the left side (**Y1**) to be "less than" the right side (**Y2**), we need to identify which side of the intersection point has **Y1** lower than **Y2** in height. The easiest way to check which graph is above the other is to use the Trace command. **Note:** Another way to differentiate graphs would be to adjust the line style, [F4] **– STYL**, of one graph on the Graph Entry page.	
4. Press [F1] – **Trace**. A cross will appear on one of the graphs with its equation at the top of the screen and the **X** and **Y-coordinates** of the point at the bottom of the screen. To switch to other graphs use the up [▲]/down [▼] arrows. Doing this, we can verify that ***x*-values** right of the intersect point make this inequality true.	

5. Now we need to know the exact value of the ***x*-value** of the intersection point. First press **F5** **– G-Solv** to see the menu options.	
6. Press **F5** **– ISCT** again to see the coordinates of the intersection point. The two graphs intersect at the point **(2,5)**. So we know the solution to the original inequality is ***x* > 2**.	

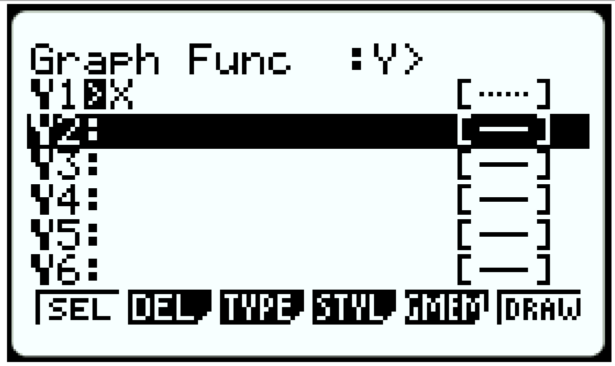
Lesson 23 – Graphing Inequalities in Two Variables

(Example: IM Lesson 23.1: Graphing Inequalities with Technology)

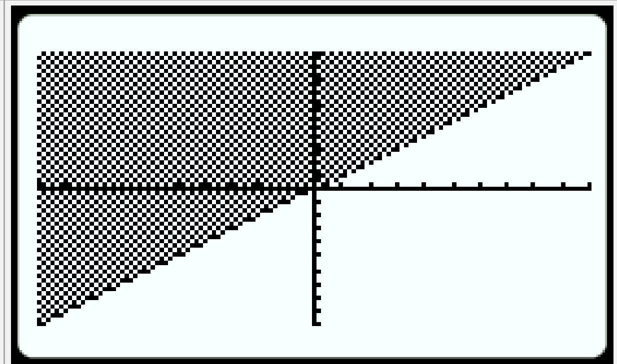
1. So far, we have graphed linear equations on the graphing calculator. In this lesson, we will use the graphing calculator to graph linear inequalities in two variables. This Warm-Up activity asks students to graph six different inequalities. Press [MENU], [5] – GRAPH to open the **Graph app**.	
2. Linear inequalities are entered very similar to linear equations. If needed, solve the inequality for ***y*** on the left side of the inequality. 3. Press [F2] **– DEL** to clear any stored functions on the graph page. A verification pop-up will open. Press [F1] for **Yes**, to delete the formula. Repeat for each prior graph in memory.	
4. To graph an inequality, first change the graph "Type" to the desired inequality **BEFORE** entering the rest of the inequality expression. 5. To select the inequality type, press [F3] – **TYPE** and then [F6] for more. Now the [F1] through [F4] buttons will have the 4 types of inequalities to graph. For the first example, ***y*** **>** ***x***, press [F1] **– Y>**.	
6. Press the right arrow, and you will have an entry box for the right side of the inequality.	

7. Now type the right side of the inequality and press EXE to finish entering this line.

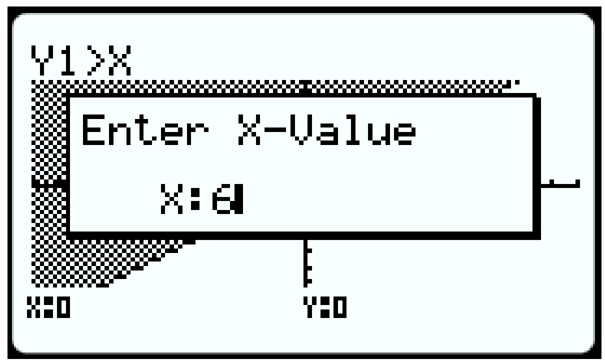
   Notice that the calculator changed the default **line style** (solid or dashed) according to the inequality type chosen.



8. Now Press F6 **– DRAW**. A graph of the inequality ***y* > *x*** will be drawn on the screen with the correct shaded solution set.

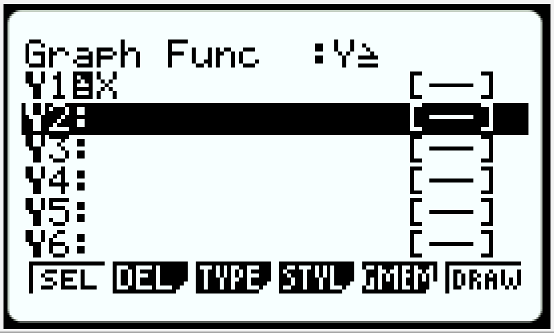


9. The trace command (F1 **– Trace**) can still be used with inequalities to find coordinates on the **boundary line** to graph by hand on a coordinate grid. Typing numbers allows for moving/jumping to exact ***x*-values** during trace. Students can record an ***x-y* value table** on their paper to plot an accurate graph by hand.

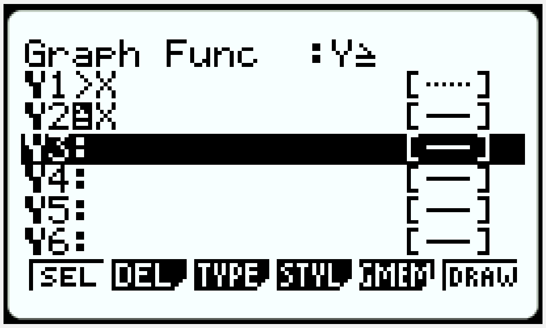


10. To graph the remaining graphs in this Warm-Up exercise, press EXIT and **either…**

    a.) Return to **Y1**, delete the prior inequality, choose the new Type, and enter the next inequality.



    b.) Press F1 **– SEL**, to “Unselect” the prior inequality, then go to the next entry line to choose the inequality **type** and enter the new inequality on the next line.

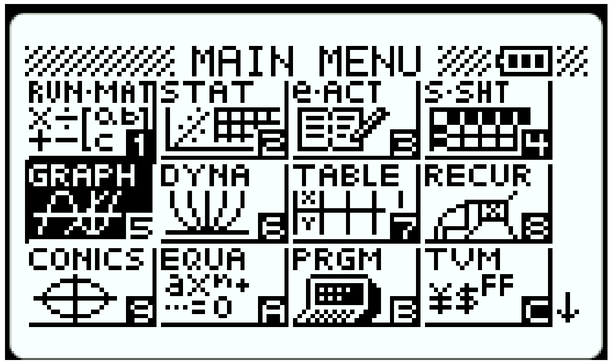


Lesson 24 – Graphing Solutions to Systems of Linear Inequalities.

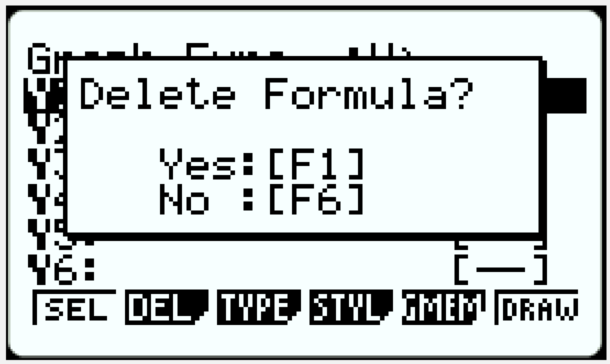
(Example IM 24.4: Scavenger Hunt)

1. This lesson is to be completed without technology in IM's instructions, however it is a nice introduction to graphing systems of inequalities on the graphing calculator.

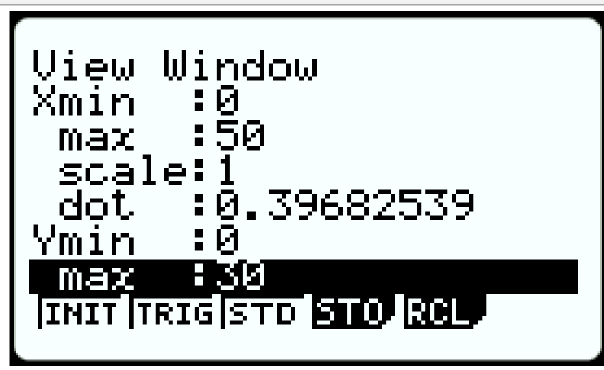
   Press [MENU], [5] – [GRAPH] to open the **Graph app**.



2. Press [F2] **– DEL** to clear any prior functions on the graph entry page. A verification pop-up will open. Press [F1] for **Yes**, to delete the formula.



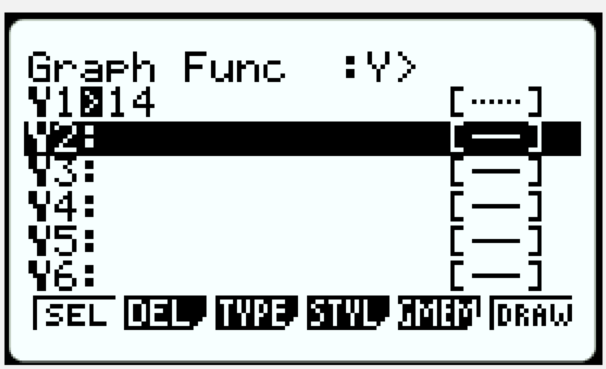
3. Press [SHIFT], [F3] **– V-Window** to adjust your viewing window to match the grid given in the problem. The system of inequalities for each of the four Clues use the window values entered to the right. Press [EXIT] to return to the **Graph Entry window**.



4. To graph a system of inequalities, graph each inequality in the system on a different entry line. Choose the **TYPE of graph** first, before entering in the rest of the inequality.

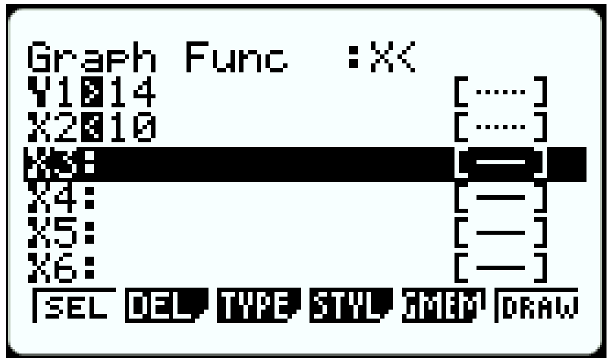
   For our 1st example, **Clue 1** has the system of inequalities ***y* > 14** and ***x* < 10**.

   To select the inequality type for ***y* > 14**, press [F3] **– TYPE** and then [F6] – [▷]. To change **Y1=** to **Y1>**, press [F1] **– Y>**. Push the right arrow button and enter 14 in the box to the right of the inequality symbol.

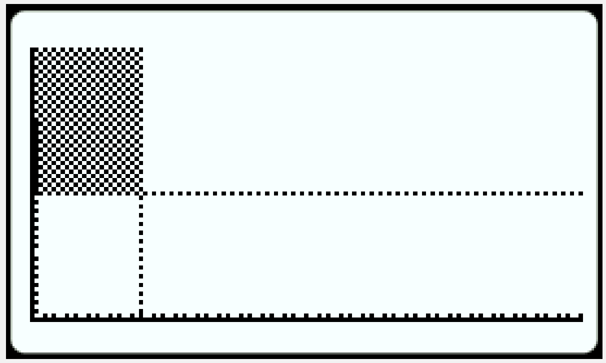


5. Next, enter in our second inequality for this system; ***x* < 10** on the line.

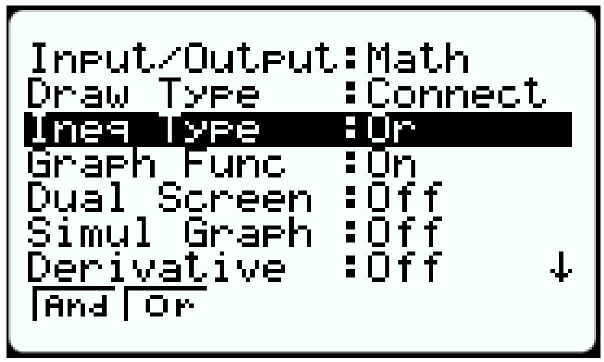
   To select the inequality type for ***x* < 10**, press [F3] **– TYPE** and then press [F6] – [▷] twice until you see [F1] through [F4] showing inequalities with ***x***. To change **Y2=** to **X2<**, press [F2] **– X<**. Push the right arrow [▶] button and enter 10 in the box to the right of the inequality symbol.



6. Now that both inequalities in our Clue 1 system are entered, press [F6] **– DRAW** to see the graph of the system. The graph shown to the right, is the default inequality setting of "***And***". This will only show the shading of the solution set of the system of inequalities. Any point in the **shaded region** will make this system of inequalities true.



7. To change the inequality set up to "***Or***", press [SHIFT], [MENU] for **SET UP**. Arrow down [▼] twice to **Ineq Type**, and press either [F1] **– And** or [F2] **– Or** to select the desired inequality graph.



8. Press [EXIT] to return to the **Graph Entry** window and press [F6] **– DRAW.** The same system of inequalities for Clue 1 is graphed again to the right. This time the inequality graph setting in **SET UP** has been changed to "***Or***". Now the shading for each inequality is done with cross hatching with overlapping cross hatching in the solution set of the system. Any point in the double cross hatching region will make this system of inequalities true.